GE Industrial Systems

489

Generator Management Relay

COMMUNICATIONS GUIDE

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489 Communications Guide

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Modbus Protocol

Electrical Interface

The hardware or electrical interface is one of the following: one of two 2-wire RS485 ports from the rear terminal connector or the RS232 from the front panel connector. In a 2-wire RS485 link, data flow is bidirectional. Data flow is half-duplex for both the RS485 and the RS232 ports. That is, data is never transmitted and received at the same time. RS485 lines should be connected in a daisy chain configuration (avoid star connections) with a terminating network installed at each end of the link, i.e. at the master end and at the slave farthest from the master. The terminating network should consist of a 120 Ω resistor in series with a 1 nF ceramic capacitor when used with Belden 9841 RS485 wire. The value of the terminating resistors should be equal to the characteristic impedance of the line. This is approximately 120 Ω for standard #22 AWG twisted pair wire. Shielded wire should always be used to minimize noise. Polarity is important in RS485 communications. Each '+' terminal of every 489 must be connected together for the system to operate. Refer to the 489 Instruction Manual for correct serial port wiring.

Modbus RTU Description

The 489 implements a subset of the AEG Modicon Modbus RTU serial communication standard. Many popular programmable controllers support this protocol directly with a suitable interface card allowing direct connection of relays. Although the Modbus protocol is hardware independent, the 489 interfaces include two 2-wire RS485 ports and one RS232 port. Modbus is a single master, multiple slave protocol suitable for a multi-drop configuration as provided by RS485 hardware. In this configuration up to 32 slaves can be daisy-chained together on a single communication channel.

The 489 is always a slave; it cannot be programmed as a master. Computers or PLCs are commonly programmed as masters. The Modbus protocol exists in two versions: Remote Terminal Unit (RTU, binary) and ASCII. Only the RTU version is supported by the 489. Monitoring, programming, and control functions are performed with read/write register commands.

Data Frame Format and Data Rate

One data frame of an asynchronous transmission to or from a 489 is default to 1 start bit, 8 data bits, and 1 stop bit. This produces a 10-bit data frame. This is important for transmission through modems at high bit rates (11 bit data frames are not supported by Hayes modems at bit rates of greater than 300 bps). The parity bit is optional as odd or even. If it is programmed as odd or even, the data frame consists of 1 start bit, 8 data bits, 1 parity bit, and 1 stop bit.

Modbus protocol can be implemented at any standard communication speed. The 489 RS485 ports support operation at 1200, 2400, 4800, 9600, and 19200 baud. The front panel RS232 baud rate is fixed at 9600 baud.

Data Packet Format

A complete request/response sequence consists of the following bytes (transmitted as separate data frames):

1. A *Master Query Message* consisting of: a 1-byte *Slave Address*, a 1-byte *Function Code*, a variable number of *Data Bytes* depending on the Function Code, and a 2-byte *CRC* code.
2. A Slave Response Message consisting of: a 1-byte *Slave Address*, a 1-byte *Function Code*, a variable number of *Data Bytes* depending on the Function Code, and a 2-byte *CRC* code.

The terms Slave Address, Function Code, Data Bytes, and CRC are explained below:

- **SLAVE ADDRESS**: This is the first byte of every transmission. This byte represents the user-assigned address of the slave device that is to receive the message sent by the master. Each slave device must be assigned a unique address and only the addressed slave will respond to a transmission that starts with its address. In a master request transmission the Slave Address represents the address of the slave to which the request is being sent. In a slave response transmission the Slave Address represents the address of the slave that is sending the response. The RS232 port ignores the slave address, so it will respond regardless of the value in the message. Note: A master transmission with a Slave Address of 0 indicates a broadcast command. Broadcast commands can be used for specific functions.
- **FUNCTION CODE**: This is the second byte of every transmission. Modbus defines function codes of 1 to 127. The 489 implements some of these functions. In a master request transmission the Function Code tells the slave what action to perform. In a slave response transmission if the Function Code sent from the slave is the same as the Function Code sent from the master indicating the slave performed the function as requested. If the high order bit of the Function Code sent from the slave is a 1 (i.e. if the Function Code is greater than 127) then the slave did not perform the function as requested and is sending an error or exception response.
- **DATA BYTES**: This is a variable number of bytes depending on the Function Code. These may be actual values, setpoints, or addresses sent by the master to the slave or vice-versa. Data is sent MSByte first followed by the LSByte.
- **CRC**: This is a two byte error checking code. CRC is sent LSByte first followed by the MSByte. The RTU version of Modbus includes a two byte CRC-16 (16-bit cyclic redundancy check) with every transmission. The CRC-16 algorithm essentially treats the entire data stream (data bits only; start, stop and parity ignored) as one continuous binary number. This number is first shifted left 16 bits and then divided by a characteristic polynomial (1100000000000101B). The 16-bit remainder of the division is appended to the end of the transmission, LSByte first. The resulting message including CRC, when divided by the same polynomial at the receiver will give a zero remainder if no transmission errors have occurred.

If a 489 Modbus slave device receives a transmission in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the transmission. A CRC-16 error indicates than one or more bytes of the transmission were received incorrectly and thus the entire transmission should be ignored in order to avoid the 489 performing any incorrect operation. The CRC-16 calculation is an industry standard method used for error detection. An algorithm is included here to assist programmers in situations where no standard CRC-16 calculation routines are available.

CRC-16 Algorithm

Once the following algorithm is complete, the working register "A" will contain the CRC value to be transmitted. Note that this algorithm requires the characteristic polynomial to be reverse bit ordered. The MSbit of the characteristic polynomial is dropped since it does not affect the value of the remainder.

The symbols used in the algorithm are shown below:

-->	data transfer
A; A_{low}; A_{high}	16-bit working register; low and high order bytes of A (the 16-bit working register)
CRC	16 bit CRC-16 result
i, j	loop counters
(+)	logical EXCLUSIVE-OR operator
N	total number of data bytes
D_i	i-th data byte (i = 0 to N – 1)
G	16 bit characteristic polynomial = 1010000000000001 (binary) with MSbit dropped and bit order reversed
shr (x)	right shift operator (the LSbit of x is shifted into a carry flag, a '0' is shifted into the MSbit of x, all other bits are shifted right one location)

The CRC algorithm is shown below:

```
1.  FFFF (hex) --> A
2.  0 --> i
3.  0 --> j
4.  Di (+) Alow --> Alow
5.  j + 1 --> j
6.  shr (A)
7.  Is there a carry? No: go to step 8.
                      Yes: G (+) A --> A and continue.
8.  Is j = 8?         No: go to 5.; Yes: continue.
9.  i + 1 --> i
10. Is i = N?         No: go to 3.; Yes: continue.
11. A --> CRC
```

Timing

Data packet synchronization is maintained by timing constraints. The receiving device must measure the time between the reception of characters. If three and one half character times elapse without a new character or completion of the packet, then the communication link must be reset (i.e. all slaves start listening for a new transmission from the master). Thus at 9600 baud a delay of greater than 3.5 × 1 / 9600 × 10 = 3.65 ms will cause the communication link to be reset.

Modbus Functions

Supported Functions

The following functions are supported by the 489:

- Function Codes 03 and 04: Read Setpoints and Actual Values
- Function Code 05: Execute Operation
- Function Code 06: Store Single Setpoint
- Function Code 07: Read Device Status
- Function Code 08: Loopback Test
- Function Code 16: Store Multiple Setpoints

A detailed explanation of how the 489 implements these function codes is shown in the following sections.

Function Codes 03/04: Read Setpoints / Actual Values

Modbus implementation: Read Input and Holding Registers
489 Implementation: Read Setpoints and Actual Values

For the 489 Modbus implementation, these commands are used to read any setpoint ('holding registers') or actual value ('input registers'). Holding and input registers are 16-bit (two byte) values transmitted high order byte first. Thus all 489 setpoints and actual values are sent as two bytes. The maximum of 125 registers can be read in one transmission. Function codes 03 and 04 are configured to read setpoints or actual values interchangeably since some PLCs do not support both function codes.

The slave response to these function codes is the slave address, function code, a count of the number of data bytes to follow, the data itself and the CRC. Each data item is sent as a two byte number with the high order byte sent first. The CRC is sent as a two byte number with the low order byte sent first.

Message Format and Example:

Request slave 11 to respond with 2 registers starting at address 0235. For this example, the register data in these addresses is:

Address	Data
0235	0064
0236	000A

Master Transmission	Bytes	Example	Description
Slave Address	1	0B	message for slave 11
Function Code	1	03	read register values
Data Starting Address	2	02 32	data starting at 0235h
Number of Setpoints	2	00 02	2 registers = 4 bytes total
CRC (low, high)	2	D5 17	computed CRC error code

Slave Response	Bytes	Example	Description
Slave Address	1	0B	message from slave 11
Function Code	1	03	read register values
Byte Count	1	04	2 registers = 4 bytes total
Data #1 (high, low)	2	00 64	value in address 0235h
Data #2 (high, low)	2	00 0A	value in address 0236h
CRC (low, high)	2	EB 91	computed CRC error code

Function Code 05: Execute Operation

Modbus Implementation: Force Single Coil
489 Implementation: Execute Operation

This function code allows the master to request specific 489 command operations. The command numbers listed in the Commands area of the memory map correspond to operation code for function code 05. The operation commands can also be initiated by writing to the Commands area of the memory map using function code 16. Refer to Section Function Code 16: Store Multiple Setpoints on page –7 for complete details.

Supported Operations:Reset 489 (operation code 1); Generator Start (operation code 2);
Generator Stop (operation code 3); Waveform Trigger (operation code 4)

Message Format and Example:

Reset 489 (operation code 1).

Master Transmission	Bytes	Example	Description
Slave Address	1	0B	message for slave 11
Function Code	1	05	execute operation
Operation Code	2	00 01	reset command (op code 1)
Code Value	2	FF 00	perform function
CRC (low, high)	2	DD 50	computed CRC error code

Slave Response	Bytes	Example	Description
Slave Address	1	0B	message from slave 11
Function Code	1	05	execute operation
Operation Code	2	00 01	reset command (op code 1)
Code Value	2	FF 00	perform function
CRC (low, high)	2	DD 50	computed CRC error code

Function Code 06: Store Single Setpoint

Modbus Implementation: Preset Single Register
489 Implementation: Store Single Setpoint

This command allows the master to store a single setpoint into the 489 memory. The slave response to this function code is to echo the entire master transmission.

Message Format and Example:

Request slave 11 to store the value 01F4 in Setpoint address 1180. After the transmission in this example is complete, Setpoints address 1180 will contain the value 01F4.

Master Transmission	Bytes	Example	Description
Slave Address	1	0B	message for slave 11
Function Code	1	06	store single setpoint
Data Starting Address	2	11 80	setpoint address 1180h
Data	2	01 F4	data for address 1180h
CRC (low, high)	2	8D A3	computed CRC error code

Slave Response	Bytes	Example	Description
Slave Address	1	0B	message from slave 11
Function Code	1	06	store single setpoint
Data Starting Address	2	11 80	setpoint address 1180h
Data	2	01 F4	data for address 1180h
CRC (low, high)	2	8D A3	computed CRC error code

Function Code 07: Read Device Status

Modbus Implementation: Read Exception Status
489 Implementation: Read Device Status

This function reads the selected device status. A short message length allows for rapid reading of status. The returned status byte has individual bits set to 1 or 0 depending on the slave device status. The 489 general status byte is shown below:

BIT	DESCRIPTION
B0	1 TRIP relay operated = 1
B1	2 AUXILIARY relay operated = 1
B2	3 AUXILIARY relay operated = 1
B3	4 AUXILIARY relay operated = 1

BIT	DESCRIPTION
B4	5 ALARM relay operated = 1
B5	6 SERVICE relay operated = 1
B6	Stopped = 1
B7	Running = 1

Note that if status is neither stopped or running, the generator is starting.

Message Format and Example:

Request status from slave 11.

Master Transmission	Bytes	Example	Description
Slave Address	1	0B	message for slave 11
Function Code	1	07	read device status
CRC (low, high)	2	47 42	computed CRC error code

Slave Response	Bytes	Example	Description
Slave Address	1	0B	message from slave 11
Function Code	1	07	read device status
Device Status	1	59	status = 01011001b
CRC (low, high)	2	C2 08	computed CRC error code

Function Code 08: Loopback Test

Modbus Implementation: Loopback Test
489 Implementation: Loopback Test

This function is used to test the integrity of the communication link. The 489 will echo the request.

Message Format and Example:

Loopback test from slave 11.

Master Transmission	Bytes	Example	Description
Slave Address	1	0B	message for slave 11
Function Code	1	08	loopback test
Diagnostic Code	2	00 00	must be 0000h
Data	2	00 00	must be 0000h
CRC (low, high)	2	E0 A1	computed CRC error code

Slave Response	Bytes	Example	Description
Slave Address	1	0B	message from slave 11
Function Code	1	08	loopback test
Diagnostic Code	2	00 00	must be 0000h
Data	2	00 00	must be 0000h
CRC (low, high)	2	E0 A1	computed CRC error code

Function Code 16: Store Multiple Setpoints

Modbus Implementation: Preset Multiple Registers
489 Implementation: Store Multiple Setpoints

This function code allows multiple Setpoints to be stored into the 489 memory. Modbus "registers" are 16-bit (two byte) values transmitted high order byte first. Thus all 489 setpoints are sent as two bytes. The maximum number of Setpoints that can be stored in one transmission is dependent on the slave device. Modbus allows up to a maximum of 60 holding registers to be stored. The 489 response to this function code is to echo the slave address, function code, starting address, the number of Setpoints stored, and the CRC.

Message Format and Example:

Request slave 11 to store the value 01F4 to Setpoint address 1180 and the value 0001 to setpoint address 1181. After the transmission in this example is complete, 489 slave 11 will have the following setpoints information stored:

Address	Data
1180	01F4
1181	0001

Master Transmission	Bytes	Example	Description
Slave Address	1	0B	message for slave 11
Function Code	1	10	store setpoints
Data Starting Address	2	11 80	data starting at 1180h
Number of Setpoints	2	00 02	2 setpoints = 4 bytes total
Byte Count	1	04	2 registers = 4 bytes
Data 1	2	01 F4	data for address 1180h
Data 2	2	00 01	data for address 1181h
CRC (low, high)	2	9B 89	computed CRC error code

Slave Response	Bytes	Example	Description
Slave Address	1	0B	message from slave 11
Function Code	1	10	store multiple setpoints
Data Starting Address	2	11 80	data starting at 1180h
Number of Setpoints	2	00 02	2 setpoints (4 bytes total)
CRC (low, high)	2	45 B6	computed CRC error code

Function Code 16: Performing Commands

Some PLCs may not support execution of commands using function code 5 but do support storing multiple setpoints using function code 16. To perform this operation using function code 16 (10h), a certain sequence of commands must be written at the same time to the 489. The sequence consists of: Command Function register, Command operation register and Command Data (if required). The Command Function register must be written with the value of 5 indicating an execute operation is requested. The Command Operation register must then be written with a valid command operation number from the list of commands shown in the memory map. The Command Data registers must be written with valid data if the command operation requires data. The selected command will execute immediately upon receipt of a valid transmission.

Message Format and Example:

Perform a 489 RESET (operation code 1).

Master Transmission	Bytes	Example	Description
Slave Address	1	0B	message for slave 11
Function Code	1	10	store setpoints
Data Starting Address	2	00 80	setpoint address 0080h
Number of Setpoints	2	00 02	2 setpoints = 4 bytes total
Byte Count	1	04	2 registers = 4 bytes
Command Function	2	00 05	data for address 0080h
Command Function	2	00 01	data for address 0081h
CRC (low, high)	2	0B D6	computed CRC error code

Slave Response	Bytes	Example	Description
Slave Address	1	0B	message from slave 11
Function Code	1	10	store multiple setpoints
Data Starting Address	2	00 80	setpoint address 0080h
Number of Setpoints	2	00 02	2 setpoints (4 bytes total)
CRC (low, high)	2	40 8A	computed CRC error code

Error Responses

When a 489 detects an error other than a CRC error, a response will be sent to the master. The MSbit of the Function Code byte will be set to 1 (i.e. the function code sent from the slave will be equal to the function code sent from the master plus 128). The following byte will be an exception code indicating the type of error that occurred.

Transmissions received from the master with CRC errors will be ignored by the 489.

The slave response to an error (other than CRC error) will be:

- SLAVE ADDRESS: 1 byte
- FUNCTION CODE: 1 byte (with MSbit set to 1)
- EXCEPTION CODE: 1 byte
- CRC: 2 bytes

The 489 implements the following exception response codes.

01: ILLEGAL FUNCTION

The function code transmitted is not one of the functions supported by the 489.

02: ILLEGAL DATA ADDRESS

The address referenced in the data field transmitted by the master is not an allowable address for the 489.

03: ILLEGAL DATA VALUE

The value referenced in the data field transmitted by the master is not within range for the selected data address.

Modbus Memory Map

Memory Map Information

The data stored in the 489 is grouped as Setpoints and Actual Values. Setpoints can be read and written by a master computer. Actual Values are read only. All Setpoints and Actual Values are stored as two byte values. That is, each register address is the address of a two-byte value. Addresses are listed in hexadecimal. Data values (Setpoint ranges, increments, and factory values) are in decimal.

Many Modbus communications drivers add 40001d to the actual address of the register addresses. For example: if address 0h was to be read, 40001d would be the address required by the Modbus communications driver; if address 320h (800d) was to be read, 40801d would be the address required by the Modbus communications driver.

User-Definable Memory Map Area

The 489 contains a User Definable area in the memory map. This area allows remapping of the addresses of all Actual Values and Setpoints registers. The User Definable area has two sections:

1. A Register Index area (memory map addresses 0180h to 01FCh) that contains 125 Actual Values or Setpoints register addresses.
2. A Register area (memory map addresses 0100h to 017Ch) that contains the data at the addresses in the Register Index.

Register data that is separated in the rest of the memory map may be remapped to adjacent register addresses in the User Definable Registers area. This is accomplished by writing to register addresses in the User Definable Register Index area. This allows for improved throughput of data and can eliminate the need for multiple read command sequences.

For example, if the values of Average Phase Current (register addresses 0412h and 0413h) and Hottest Stator RTD Temperature (register address 04A0h) are required to be read from an 489, their addresses may be remapped as follows:

1. Write 0412h to address 0180h (User Definable Register Index 0000) using function code 06 or 16.
2. Write 0413h to address 0181h (User Definable Register Index 0001) using function code 06 or 16.
   (Average Phase Current is a double register number)
3. Write 04A0h to address 0182h (User Definable Register Index 0001) using function code 06 or 16.

A read (function code 03 or 04) of registers 0100h (User Definable Register 0000) and 0101h (User Definable Register 0001) will return the Average Phase Current and register 0102h (User Definable Register 0002) will return the Hottest Stator RTD Temperature.

Event Recorder

The 489 event recorder data starts at address 3000h. Address 3003h is the ID number of the event of interest (a high number representing the latest event and a low number representing the oldest event). Event numbers start at zero each time the event record is cleared, and count upwards. To retrieve event 1, write '1' to the Event Record Selector (3003h) and read the data from 3004h to 30E7h. To retrieve event 2, write '2' to the Event Record Selector (3003h) and read the data from 3004h to 30E7h. All 40 events may be retrieved in this manner. The time and date stamp of each event may be used to ensure that all events have been retrieved in order without new events corrupting the sequence of events (event 0 should be less recent than event 1, event 1 should be less recent than event 2, etc.).

If more than 40 events have been recorded since the last time the event record was cleared, the earliest events will not be accessible. For example, if 100 events have been recorded (i.e., the total events since last clear in register 3002h is 100), events 60 through 99 may be retrieved. Writing any other value to the event record selector (register 3003h) will result in an "invalid data value" error.

Each communications port can individually select the ID number of the event of interest by writing address 3003h. This way the front port, rear port and auxiliary port can read different events from the event recorder simultaneously.

Waveform Capture

The 489 stores up to 64 cycles of A/D samples in a waveform capture buffer each time a trip occurs. The waveform capture buffer is time and date stamped and may therefore be correlated to a trip in the event record. To access the waveform capture memory, select the channel of interest by writing the number to the Waveform Capture Channel Selector (30F5h). Then read the waveform capture data from address 3100h-31BFh, and read the date, time and line frequency from addresses 30F0h-30F4h.

Each communications port can individually select a Waveform Channel Selector of interest by writing address 30F5h. This way the front port, rear port and auxiliary port can read different Waveform Channels simultaneously.

The channel selector must be one of the following values:

VALUE	SELECTED A/D SAMPLES	SCALE FACTOR
0	Phase A line current	500 counts equals 1 × CT primary
1	Phase B line current	500 counts equals 1 × CT primary
2	Phase C line current	500 counts equals 1 × CT primary
3	Neutral-End phase A current	500 counts equals 1 × CT primary
4	Neutral-End phase B current	500 counts equals 1 × CT primary
5	Neutral-End phase C current	500 counts equals 1 × CT primary
6	Ground current	500 counts equals 1 × CT primary or 1A for 50:0.025
7	Phase A to neutral voltage	2500 counts equals 120 secondary volts
8	Phase B to neutral voltage	2500 counts equals 120 secondary volts
9	Phase C to neutral voltage	2500 counts equals 120 secondary volts

Dual Setpoints

Each communications port can individually select an Edit Setpoint Group of interest by writing address 1342h. This way the front port, rear port and auxiliary port can read and alter different setpoints simultaneously.

Passcode Operation

Each communications port can individually set the Passcode Access by writing address 88h with the correct Passcode. This way the front port, rear port and auxiliary port have individual access to the setpoints. Reading address 0203h, COMMUNICATIONS SETPOINT ACCESS register, provides the user with the current state of access for the given port. A value of 1 read from this register indicates that the user has full access rights to changing setpoints from the given port.

489 Memory Map

The 489 memory map is shown in the following table.

Table 1: 489 Memory Map (Sheet 1 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
PRODUCT ID						
0000	GE Multilin Product Device Code	N/A	N/A	N/A	F1	32
0001	Product Hardware Revision	1 to 26	1	N/A	F15	N/A
0002	Product Software Revision	N/A	N/A	N/A	F16	N/A
0003	Product Modification Number	0 to 999	1	N/A	F1	N/A
0010	Boot Program Revision	N/A	N/A	N/A	F16	N/A
0011	Boot Program Modification Number	0 to 999	1	N/A	F1	N/A
MODEL ID						
0040	Order Code	0 to 16	1	N/A	F22	N/A
0050	489 Revision	12	1	N/A	F22	N/A
0060	489 Boot Revision	12	1	N/A	F22	N/A
COMMANDS						
0080	Command Function Code (always 5)	5	N/A	N/A	F1	N/A
0081	Command Operation Code	0 to 65535	1	N/A	F1	N/A
0088	Communications Port Passcode	0 to 99999999	1	N/A	F12	0
00F0	Time (Broadcast)	N/A	N/A	N/A	F24	N/A
00F2	Date (Broadcast)	N/A	N/A	N/A	F18	N/A
USER_MAP / USER MAP VALUES						
0100	User Map Value #1 of 125...	5	N/A	N/A	F1	N/A
017C	User Map Value #125 of 125	5	N/A	N/A	F1	N/A
USER_MAP / USER MAP ADDRESSES						
0180	User Map Address #1 of 125...	0 to 3FFF	1	hex	F1	0
01FC	User Map Address #125 of 125	0 to 3FFF	1	hex	F1	0
STATUS / GENERATOR STATUS						
0200	Generator Status	0 to 4	1	–	F133	1
0201	Generator Thermal Capacity Used	0 to 100	1	%	F1	0
0202	Estimated Trip Time On Overload	0 to 65535 [1]	1	s	F12	–1
0203	Communications Setpoint Access	0 to 1	N/A	N/A	F126	N/A
STATUS / SYSTEM STATUS						
0210	General Status	0 to 65535	1	N/A	F140	0
0211	Output Relay Status	0 to 63	1	N/A	F141	0
0212	Active Setpoint Group	0 to 1	1	N/A	F118	0
STATUS / LAST TRIP DATA						
0220	Cause of Last Trip	0 to 139	1	–	F134	0
0221	Time of Last Trip	N/A	N/A	N/A	F19	N/A
0223	Date of Last Trip	N/A	N/A	N/A	F18	N/A
0225	Tachometer Pretrip	0 to 7200	1	RPM	F1	0
0226	Phase A Pre-Trip Current	0 to 999999	1	Amps	F12	0
0228	Phase B Pre-Trip Current	0 to 999999	1	Amps	F12	0
022A	Phase C Pre-Trip Current	0 to 999999	1	Amps	F12	0
022C	Phase A Pre-Trip Differential Current	0 to 999999	1	Amps	F12	0
022E	Phase B Pre-Trip Differential Current	0 to 999999	1	Amps	F12	0
0230	Phase C Pre-Trip Differential Current	0 to 999999	1	Amps	F12	0
0232	Negative Sequence Current Pretrip	0 to 2000	1	% FLA	F1	0
0233	Ground Current Pretrip	0 to 20000000	1	A	F14	0
0235	Pre-Trip A-B Voltage	0 to 50000	1	Volts	F1	0
0236	Pre-Trip B-C Voltage	0 to 50000	1	Volts	F1	0
0237	Pre-Trip C-A Voltage	0 to 50000	1	Volts	F1	0
0238	Frequency Pretrip	0 to 12000	1	Hz	F3	0
023B	Real Power (MW) Pretrip	–2000000 to 2000000	1	MW	F13	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 2 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
023D	Reactive Power Mvar Pretrip	–2000000 to 2000000	1	Mvar	F13	0
023F	Apparent Power MVA Pretrip	0 to 2000000	1	MVA	F13	0
0241	Last Trip Data Stator RTD	1 to 12	1	–	F1	1
0242	Hottest Stator RTD Temperature	–50 to 250	1	°C	F4	0
0243	Last Trip Data Bearing RTD	1 to 12	1	–	F1	1
0244	Hottest Bearing RTD Temperature	–50 to 250	1	°C	F4	0
0245	Last Trip Data Other RTD	1 to 12	1	–	F1	1
0246	Hottest Other RTD Temperature	–50 to 250	1	°C	F4	0
0247	Last Trip Data Ambient RTD	1 to 12	1	–	F1	1
0248	Hottest Ambient RTD Temperature	–50 to 250	1	°C	F4	0
0249	Analog Input 1 Pretrip	–50000 to 50000	1	Units	F12	0
024B	Analog Input 2 Pretrip	–50000 to 50000	1	Units	F12	0
024D	Analog Input 3 Pretrip	–50000 to 50000	1	Units	F12	0
024F	Analog Input 4 Pretrip	–50000 to 50000	1	Units	F12	0
025C	Hottest Stator RTD Temperature	–50 to 250	1	°F	F4	0
025D	Hottest Bearing RTD Temperature	–50 to 250	1	°F	F4	0
025E	Hottest Other RTD Temperature	–50 to 250	1	°F	F4	0
025F	Hottest Ambient RTD Temperature	–50 to 250	1	°F	F4	0
0260	Neutral Voltage Fundamental Pretrip	0 to 250000	1	Volts	F10	0
0262	Neutral Voltage 3rd Harmonic Pretrip	0 to 250000	1	Volts	F10	0
0264	Pre-Trip Vab/Iab	0 to 65535	1	ohms s	F2	0
0265	Pre-Trip Vab/Iab Angle	0 to 359	1	°	F1	0
STATUS / TRIP PICKUPS						
0280	Input A Pickup	0 to 4	1	–	F123	0
0281	Input B Pickup	0 to 4	1	–	F123	0
0282	Input C Pickup	0 to 4	1	–	F123	0
0283	Input D Pickup	0 to 4	1	–	F123	0
0284	Input E Pickup	0 to 4	1	–	F123	0
0285	Input F Pickup	0 to 4	1	–	F123	0
0286	Input G Pickup	0 to 4	1	–	F123	0
0287	Sequential Trip Pickup	0 to 4	1	–	F123	0
0288	Field-Breaker Discrepancy Pickup	0 to 4	1	–	F123	0
0289	Tachometer Pickup	0 to 4	1	–	F123	0
028A	Offline Overcurrent Pickup	0 to 4	1	–	F123	0
028B	Inadvertent Energization Pickup	0 to 4	1	–	F123	0
028C	Phase Overcurrent Pickup	0 to 4	1	–	F123	0
028D	Negative Sequence Overcurrent Pickup	0 to 4	1	–	F123	0
028E	Ground Overcurrent Pickup	0 to 4	1	–	F123	0
028F	Phase Differential Pickup	0 to 4	1	–	F123	0
0290	Undervoltage Pickup	0 to 4	1	–	F123	0
0291	Overvoltage Pickup	0 to 4	1	–	F123	0
0292	Volts/Hertz Pickup	0 to 4	1	–	F123	0
0293	Phase Reversal Pickup	0 to 4	1	–	F123	0
0294	Underfrequency Pickup	0 to 4	1	–	F123	0
0295	Overfrequency Pickup	0 to 4	1	–	F123	0
0296	Neutral Overvoltage (Fundamental) Pickup	0 to 4	1	–	F123	0
0297	Neutral Undervoltage (3rd Harmonic) Pickup	0 to 4	1	–	F123	0
0298	Reactive Power Pickup	0 to 4	1	–	F123	0
0299	Reverse Power Pickup	0 to 4	1	–	F123	0
029A	Low Forward Power Pickup	0 to 4	1	–	F123	0
029B	Thermal Model Pickup	0 to 4	1	–	F123	0
029C	RTD #1 Pickup	0 to 4	1	–	F123	0
029D	RTD #2 Pickup	0 to 4	1	–	F123	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 3 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
029E	RTD #3 Pickup	0 to 4	1	–	F123	0
029F	RTD #4 Pickup	0 to 4	1	–	F123	0
02A0	RTD #5 Pickup	0 to 4	1	–	F123	0
02A1	RTD #6 Pickup	0 to 4	1	–	F123	0
02A2	RTD #7 Pickup	0 to 4	1	–	F123	0
02A3	RTD #8 Pickup	0 to 4	1	–	F123	0
02A4	RTD #9 Pickup	0 to 4	1	–	F123	0
02A5	RTD #10 Pickup	0 to 4	1	–	F123	0
02A6	RTD #11 Pickup	0 to 4	1	–	F123	0
02A7	RTD #12 Pickup	0 to 4	1	–	F123	0
02A8	Analog Input 1 Pickup	0 to 4	1	–	F123	0
02A9	Analog Input 2 Pickup	0 to 4	1	–	F123	0
02AA	Analog Input 3 Pickup	0 to 4	1	–	F123	0
02AB	Analog Input 4 Pickup	0 to 4	1	–	F123	0
02AC	Loss Of Excitation 1 Pickup	0 to 4	1	–	F123	0
02AD	Loss Of Excitation 2 Pickup	0 to 4	1	–	F123	0
02AE	Ground Directional Pickup	0 to 4	1	–	F123	0
02AF	High-Set Phase Overcurrent Pickup	0 to 4	1	–	F123	0
02B0	Distance Zone 1 Pickup	0 to 4	1	–	F123	0
02B1	Distance Zone 2 Pickup	0 to 4	1	–	F123	0
STATUS / ALARM PICKUPS						
0300	Input A Pickup	0 to 4	1	–	F123	0
0301	Input B Pickup	0 to 4	1	–	F123	0
0302	Input C Pickup	0 to 4	1	–	F123	0
0303	Input D Pickup	0 to 4	1	–	F123	0
0304	Input E Pickup	0 to 4	1	–	F123	0
0305	Input F Pickup	0 to 4	1	–	F123	0
0306	Input G Pickup	0 to 4	1	–	F123	0
0307	Tachometer Pickup	0 to 4	1	–	F123	0
0308	Overcurrent Pickup	0 to 4	1	–	F123	0
0309	Negative Sequence Overcurrent Pickup	0 to 4	1	–	F123	0
030A	Ground Overcurrent Pickup	0 to 4	1	–	F123	0
030B	Undervoltage Pickup	0 to 4	1	–	F123	0
030C	Overvoltage Pickup	0 to 4	1	–	F123	0
030D	Volts/Hertz Pickup	0 to 4	1	–	F123	0
030E	Underfrequency Pickup	0 to 4	1	–	F123	0
030F	Overfrequency Pickup	0 to 4	1	–	F123	0
0310	Neutral Overvoltage (Fundamental) Pickup	0 to 4	1	–	F123	0
0311	Neutral Undervoltage (3rd harmonic) Pickup	0 to 4	1	–	F123	0
0312	Reactive Power Pickup	0 to 4	1	–	F123	0
0313	Reverse Power Pickup	0 to 4	1	–	F123	0
0314	Low Forward Power Pickup	0 to 4	1	–	F123	0
0315	RTD #1 Pickup	0 to 4	1	–	F123	0
0316	RTD #2 Pickup	0 to 4	1	–	F123	0
0317	RTD #3 Pickup	0 to 4	1	–	F123	0
0318	RTD #4 Pickup	0 to 4	1	–	F123	0
0319	RTD #5 Pickup	0 to 4	1	–	F123	0
031A	RTD #6 Pickup	0 to 4	1	–	F123	0
031B	RTD #7 Pickup	0 to 4	1	–	F123	0
031C	RTD #8 Pickup	0 to 4	1	–	F123	0
031D	RTD #9 Pickup	0 to 4	1	–	F123	0
031E	RTD #10 Pickup	0 to 4	1	–	F123	0
031F	RTD #11 Pickup	0 to 4	1	–	F123	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 4 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
0320	RTD #12 Pickup	0 to 4	1	–	F123	0
0321	Open Sensor Pickup	0 to 4	1	–	F123	0
0322	Short/Low Temperature Pickup	0 to 4	1	–	F123	0
0323	Thermal Model Pickup	0 to 4	1	–	F123	0
0324	Trip Counter Pickup	0 to 4	1	–	F123	0
0325	Breaker Failure Pickup	0 to 4	1	–	F123	0
0326	Trip Coil Monitor Pickup	0 to 4	1	–	F123	0
0327	VT Fuse Failure Pickup	0 to 4	1	–	F123	0
0328	Current Demand Pickup	0 to 4	1	–	F123	0
0329	MW Demand Pickup	0 to 4	1	–	F123	0
032A	Mvar Demand Pickup	0 to 4	1	–	F123	0
032B	MVA Demand Pickup	0 to 4	1	–	F123	0
032C	Analog Input 1 Pickup	0 to 4	1	–	F123	0
032D	Analog Input 2 Pickup	0 to 4	1	–	F123	0
032E	Analog Input 3 Pickup	0 to 4	1	–	F123	0
032F	Analog Input 4 Pickup	0 to 4	1	–	F123	0
0330	Not Programmed Pickup	0 to 4	1	–	F123	0
0331	Simulation Mode Pickup	0 to 4	1	–	F123	0
0332	Output Relays Forced Pickup	0 to 4	1	–	F123	0
0333	Analog Output Forced Pickup	0 to 4	1	–	F123	0
0334	Test Switch Shorted Pickup	0 to 4	1	–	F123	0
0335	Ground Directional Pickup	0 to 4	1	–	F123	0
0336	IRIG-B Alarm Pickup	0 to 4	1	–	F123	0
0337	Generator Running Hour Pickup	0 to 4	1	–	F123	0
STATUS / DIGITAL INPUTS						
0380	Access Switch State	0 to 1	1	–	F207	0
0381	Breaker Status Switch State	0 to 1	1	–	F207	0
0382	Assignable Digital Input 1 State	0 to 1	1	–	F207	0
0383	Assignable Digital Input 2 State	0 to 1	1	–	F207	0
0384	Assignable Digital Input 3 State	0 to 1	1	–	F207	0
0385	Assignable Digital Input 4 State	0 to 1	1	–	F207	0
0386	Assignable Digital Input 5 State	0 to 1	1	–	F207	0
0387	Assignable Digital Input 6 State	0 to 1	1	–	F207	0
0388	Assignable Digital Input 7 State	0 to 1	1	–	F207	0
0389	Trip Coil Supervision	0 to 1	1	–	F132	0
STATUS / REAL TIME CLOCK						
03FC	Date (Read-only)	N/A	N/A	N/A	F18	N/A
03FE	Time (Read-only)	N/A	N/A	N/A	F19	N/A
METERING DATA / CURRENT METERING						
0400	Phase A Output Current	0 to 999999	1	Amps	F12	0
0402	Phase B Output Current	0 to 999999	1	Amps	F12	0
0404	Phase C Output Current	0 to 999999	1	Amps	F12	0
0406	Phase A Neutral-Side Current	0 to 999999	1	Amps	F12	0
0408	Phase B Neutral-Side Current	0 to 999999	1	Amps	F12	0
040A	Phase C Neutral-Side Current	0 to 999999	1	Amps	F12	0
040C	Phase A Differential Current	0 to 999999	1	Amps	F12	0
040E	Phase B Differential Current	0 to 999999	1	Amps	F12	0
0410	Phase C Differential Current	0 to 999999	1	Amps	F12	0
0412	Average Phase Current	0 to 999999	1	Amps	F12	0
0414	Generator Load	0 to 2000	1	% FLA	F1	0
0415	Negative Sequence Current	0 to 2000	1	% FLA	F1	0
0416	Ground Current	0 to 10000	1	Amps	F14	0
0420	Phase A Current Angle	0 to 359	1	°	F1	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 5 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
0421	Phase B Current Angle	0 to 359	1	°	F1	0
0422	Phase C Current Angle	0 to 359	1	°	F1	0
0423	Phase A Neutral-Side Angle	0 to 359	1	°	F1	0
0424	Phase B Neutral-Side Angle	0 to 359	1	°	F1	0
0425	Phase C Neutral-Side Angle	0 to 359	1	°	F1	0
0426	Phase A Differential Angle	0 to 359	1	°	F1	0
0427	Phase B Differential Angle	0 to 359	1	°	F1	0
0428	Phase C Differential Angle	0 to 359	1	°	F1	0
0429	Ground Current Angle	0 to 359	1	°	F1	0
METERING DATA / VOLTAGE METERING						
0440	Phase A-B Voltage	0 to 50000	1	Volts	F1	0
0441	Phase B-C Voltage	0 to 50000	1	Volts	F1	0
0442	Phase C-A Voltage	0 to 50000	1	Volts	F1	0
0443	Average Line Voltage	0 to 50000	1	Volts	F1	0
0444	Phase A-N Voltage	0 to 50000	1	Volts	F1	0
0445	Phase B-N Voltage	0 to 50000	1	Volts	F1	0
0446	Phase C-N Voltage	0 to 50000	1	Volts	F1	0
0447	Average Phase Voltage	0 to 50000	1	Volts	F1	0
0448	Per Unit Measurement Of V/Hz^2	0 to 200	1	–	F3	0
0449	Frequency	500 to 9000	1	Hz	F3	0
044A	Neutral Voltage Fund	0 to 250000	1	Volts	F10	0
044C	Neutral Voltage 3rd Harmonic	0 to 250000	1	Volts	F10	0
044E	Neutral Voltage Vp3 3rd Harmonic	0 to 250000	1	Volts	F10	0
0450	Vab/Iab	0 to 65535	1	ohms	F2	0
0451	Vab/Iab Angle	0 to 359	1	°	F1	0
0460	Line A-B Voltage Angle	0 to 359	1	°	F1	0
0461	Line B-C Voltage Angle	0 to 359	1	°	F1	0
0462	Line C-A Voltage Angle	0 to 359	1	°	F1	0
0463	Phase A-N Voltage Angle	0 to 359	1	°	F1	0
0464	Phase B-N Voltage Angle	0 to 359	1	°	F1	0
0465	Phase C-N Voltage Angle	0 to 359	1	°	F1	0
0466	Neutral Voltage Angle	0 to 359	1	–	F1	0
METERING DATA / POWER METERING						
0480	Power Factor	–100 to 100	1	–	F6	0
0481	Real Power	–2000000 to 2000000	1	MW	F13	0
0483	Reactive Power	–2000000 to 2000000	1	Mvar	F13	0
0485	Apparent Power	–2000000 to 200000	1	MVA	F13	0
0487	Positive Watthours	0 to 4000000000	1	MWh	F13	0
0489	Positive Varhours	0 to 4000000000	1	Mvarh	F13	0
048B	Negative Varhours	0 to 4000000000	1	Mvarh	F13	0
METERING DATA / TEMPERATURE						
04A0	Hottest Stator RTD	1 to 12	1	–	F1	0
04A1	Hottest Stator RTD Temperature	–52 to 250	1	°C	F4	–52
04A2	RTD #1 Temperature	–52 to 251	1	°C	F4	–52
04A3	RTD #2 Temperature	–52 to 251	1	°C	F4	–52
04A4	RTD #3 Temperature	–52 to 251	1	°C	F4	–52
04A5	RTD #4 Temperature	–52 to 251	1	°C	F4	–52
04A6	RTD #5 Temperature	–52 to 251	1	°C	F4	–52
04A7	RTD #6 Temperature	–52 to 251	1	°C	F4	–52
04A8	RTD #7 Temperature	–52 to 251	1	°C	F4	–52
04A9	RTD #8 Temperature	–52 to 251	1	°C	F4	–52
04AA	RTD #9 Temperature	–52 to 251	1	°C	F4	–52
04AB	RTD #10 Temperature	–52 to 251	1	°C	F4	–52

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 6 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
04AC	RTD #11 Temperature	–52 to 251	1	°C	F4	–52
04AD	RTD #12 Temperature	–52 to 251	1	°C	F4	–52
04C0	Hottest Stator RTD Temperature	–52 to 250	1	°F	F4	–52
04C1	RTD #1 Temperature	–52 to 251	1	°F	F4	–52
04C2	RTD #2 Temperature	–52 to 251	1	°F	F4	–52
04C3	RTD #3 Temperature	–52 to 251	1	°F	F4	–52
04C4	RTD #4 Temperature	–52 to 251	1	°F	F4	–52
04C5	RTD #5 Temperature	–52 to 251	1	°F	F4	–52
04C6	RTD #6 Temperature	–52 to 251	1	°F	F4	–52
04C7	RTD #7 Temperature	–52 to 251	1	°F	F4	–52
04C8	RTD #8 Temperature	–52 to 251	1	°F	F4	–52
04C9	RTD #9 Temperature	–52 to 251	1	°F	F4	–52
04CA	RTD #10 Temperature	–52 to 251	1	°F	F4	–52
04CB	RTD #11 Temperature	–52 to 251	1	°F	F4	–52
04CC	RTD #12 Temperature	–52 to 251	1	°F	F4	–52
METERING DATA / DEMAND METERING						
04E0	Current Demand	0 to 1000000	1	Amps	F12	0
04E2	MW Demand	0 to 2000000	1	MW	F13	0
04E4	Mvar Demand	0 to 2000000	1	Mvar	F13	0
04E6	MVA Demand	0 to 2000000	1	MVA	F13	0
04E8	Peak Current Demand	0 to 1000000	1	Amps	F12	0
04EA	Peak MW Demand	0 to 2000000	1	MW	F13	0
04EC	Peak Mvar Demand	0 to 2000000	1	Mvar	F13	0
04EE	Peak MVA Demand	0 to 2000000	1	MVA	F13	0
METERING DATA / ANALOG INPUTS						
0500	Analog Input 1	–50000 to 50000	1	Units	F12	0
0502	Analog Input 2	–50000 to 50000	1	Units	F12	0
0504	Analog Input 3	–50000 to 50000	1	Units	F12	0
0506	Analog Input 4	–50000 to 50000	1	Units	F12	0
METERING DATA / SPEED						
0520	Tachometer	0 to 7200	1	RPM	F1	0
LEARNED DATA / PARAMETER AVERAGES						
0600	Average Generator Load	0 to 2000	1	%FLA	F1	0
0601	Average Negative Sequence Current	0 to 2000	1	%FLA	F1	0
0602	Average Phase-Phase Voltage	0 to 50000	1	V	F1	0
0603	Reserved	–	–	–	–	–
0604	Reserved	–	–	–	–	–
LEARNED DATA / RTD MAXIMUMS						
0620	RTD #1 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0621	RTD #2 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0622	RTD #3 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0623	RTD #4 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0624	RTD #5 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0625	RTD #6 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0626	RTD #7 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0627	RTD #8 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0628	RTD #9 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0629	RTD #10 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
062A	RTD #11 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
062B	RTD #12 Maximum Temperature (Celsius)	–52 to 251	1	°C	F4	–52
0640	RTD #1 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
0641	RTD #2 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
0642	RTD #3 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 7 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
0643	RTD #4 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
0644	RTD #5 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
0645	RTD #6 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
0646	RTD #7 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
0647	RTD #8 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
0648	RTD #9 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
0649	RTD #10 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
064A	RTD #11 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
064B	RTD #12 Maximum Temperature (Fahrenheit)	–52 to 251	1	°F	F4	–52
LEARNED DATA / ANALOG IN MIN/MAX						
0700	Analog Input 1 Minimum	–50000 to 50000	1	Units	F12	0
0702	Analog Input 1 Maximum	–50000 to 50000	1	Units	F12	0
0704	Analog Input 2 Minimum	–50000 to 50000	1	Units	F12	0
0706	Analog Input 2 Maximum	–50000 to 50000	1	Units	F12	0
0708	Analog Input 3 Minimum	–50000 to 50000	1	Units	F12	0
070A	Analog Input 3 Maximum	–50000 to 50000	1	Units	F12	0
070C	Analog Input 4 Minimum	–50000 to 50000	1	Units	F12	0
070E	Analog Input 4 Maximum	–50000 to 50000	1	Units	F12	0
MAINTENANCE / TRIP COUNTERS						
077F	Trip Counters Last Cleared (Date)	N/A	N/A	N/A	F18	N/A
0781	Total Number of Trips	0 to 50000	1	–	F1	0
0782	Digital Input Trips	0 to 50000	1	–	F1	0
0783	Sequential Trips	0 to 50000	1	–	F1	0
0784	Field-Breaker Discrepancy Trips	0 to 50000	1	–	F1	0
0785	Tachometer Trips	0 to 50000	1	–	F1	0
0786	Offline Overcurrent Trips	0 to 50000	1	–	F1	0
0787	Phase Overcurrent Trips	0 to 50000	1	–	F1	0
0788	Negative Sequence Overcurrent Trips	0 to 50000	1	–	F1	0
0789	Ground Overcurrent Trips	0 to 50000	1	–	F1	0
078A	Phase Differential Trips	0 to 50000	1	–	F1	0
078B	Undervoltage Trips	0 to 50000	1	–	F1	0
078C	Overvoltage Trips	0 to 50000	1	–	F1	0
078D	Volts/Hertz Trips	0 to 50000	1	–	F1	0
078E	Phase Reversal Trips	0 to 50000	1	–	F1	0
078F	Underfrequency Trips	0 to 50000	1	–	F1	0
0790	Overfrequency Trips	0 to 50000	1	–	F1	0
0791	Neutral Overvoltage (Fundamental) Trips	0 to 50000	1	–	F1	0
0792	Neutral Undervoltage (3rd Harmonic) Trips	0 to 50000	1	–	F1	0
0793	Reactive Power Trips	0 to 50000	1	–	F1	0
0794	Reverse Power Trips	0 to 50000	1	–	F1	0
0795	Low Forward Power Trips	0 to 50000	1	–	F1	0
0796	Stator RTD Trips	0 to 50000	1	–	F1	0
0797	Bearing RTD Trips	0 to 50000	1	–	F1	0
0798	Other RTD Trips	0 to 50000	1	–	F1	0
0799	Ambient RTD Trips	0 to 50000	1	–	F1	0
079A	Thermal Model Trips	0 to 50000	1	–	F1	0
079B	Inadvertent Energization Trips	0 to 50000	1	–	F1	0
079C	Analog Input 1 Trips	0 to 50000	1	–	F1	0
079D	Analog Input 2 Trips	0 to 50000	1	–	F1	0
079E	Analog Input 3 Trips	0 to 50000	1	–	F1	0
079F	Analog Input 4 Trips	0 to 50000	1	–	F1	0
MAINTENANCE / GENERAL COUNTERS						
07A0	Number Of Breaker Operations	0 to 50000	1	–	F1	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 8 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
07A1	Number Of Thermal Resets	0 to 50000	1	–	F1	0
MAINTENANCE / TRIP COUNTERS						
07A2	Loss Of Excitation 1 Trips	0 to 50000	1	–	F1	0
07A3	Loss Of Excitation 2 Trips	0 to 50000	1	–	F1	0
07A4	Ground Directional Trips	0 to 50000	1	–	F1	0
07A5	High-Set Phase Overcurrent Trips	0 to 50000	1	–	F1	0
07A6	Distance Zone 1 Trips	0 to 50000	1	–	F1	0
07A7	Distance Zone 2 Trips	0 to 50000	1	–	F1	0
MAINTENANCE / TIMERS						
07E0	Generator Hours Online	0 to 1000000	1	h	F12	0
PRODUCT INFO. / 489 MODEL INFO.						
0800	Order Code	0 to 65535	1	N/A	F136	N/A
0801	489 Serial Number	3000000 to 9999999	1	–	F12	3000000
PRODUCT INFO. / CALIBRATION INFO.						
0810	Original Calibration Date	N/A	N/A	N/A	F18	N/A
0812	Last Calibration Date	N/A	N/A	N/A	F18	N/A
489 SETUP / PREFERENCES						
1000	Default Message Cycle Time	5 to 100	5	s	F2	20
1001	Default Message Timeout	10 to 900	1	s	F1	300
1003	Parameter Averages Calculation Period	1 to 90	1	min	F1	15
1004	Temperature Display	0 to 1	1	–	F100	0
1005	Waveform Trigger Position	1 to 100	1	%	F1	25
1006	Passcode (Write Only)	0 to 99999999	1	N/A	F12	0
1008	Encrypted Passcode (Read Only)	N/A	N/A	N/A	F12	N/A
100A	Waveform Memory Buffer	1 to 16	1	–	F1	8
489 SETUP / SERIAL PORTS						
1010	Slave Address	1 to 254	1	–	F1	254
1011	Computer RS485 Baud Rate	0 to 5	1	–	F101	4
1012	Computer RS485 Parity	0 to 2	1	–	F102	0
1013	Auxiliary RS485 Baud Rate	0 to 5	1	–	F101	4
1014	Auxiliary RS485 Parity	0 to 2	1	–	F102	0
1015	Port Used For DNP	0 to 3	1	–	F216	0
1016	DNP Slave Address	0 to 255	1	–	F1	255
1017	DNP Turnaround Time	0 to 100	10	ms	F1	10
489 SETUP / REAL TIME CLOCK						
1030	Date	N/A	N/A	N/A	F18	N/A
1032	Time	N/A	N/A	N/A	F19	N/A
1034	IRIG-B Type	0 to 2	1	–	F220	0
489 SETUP / MESSAGE SCRATCHPAD						
1060	Scratchpad	0 to 40	1	–	F22	_
1080	Scratchpad	0 to 40	1	–	F22	_
10A0	Scratchpad	0 to 40	1	–	F22	_
10C0	Scratchpad	0 to 40	1	–	F22	_
10E0	Scratchpad	0 to 40	1	–	F22	_
489 SETUP / CLEAR DATA						
1130	Clear Last Trip Data	0 to 1	1	–	F103	0
1131	Clear Mwh And Mvarh Meters	0 to 1	1	–	F103	0
1132	Clear Peak Demand Data	0 to 1	1	–	F103	0
1133	Clear RTD Maximums	0 to 1	1	–	F103	0
1134	Clear Analog Inputs Minimums/Maximums	0 to 1	1	–	F103	0
1135	Clear Trip Counters	0 to 1	1	–	F103	0
1136	Clear Event Record	0 to 1	1	–	F103	0
1137	Clear Generator Information	0 to 1	1	–	F103	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 9 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
1138	Clear Breaker Information	0 to 1	1	–	F103	0
SYSTEM SETUP / CURRENT SENSING						
1180	Phase CT Primary	10 to 50001	1	Amps	F1	50001
1181	Ground CT	0 to 3	1	–	F104	0
1182	Ground CT Ratio	10 to 10000	1	: 1 / :5	F1	100
SYSTEM SETUP / VOLTAGE SENSING						
11A0	VT Connection Type	0 to 2	1	–	F106	0
11A1	Voltage Transformer Ratio	100 to 30000	1	: 1	F3	500
11A2	Neutral VT Ratio	100 to 24000	1	: 1	F3	500
11A3	Neutral Voltage Transformer	0 to 1	1	–	F103	0
SYSTEM SETUP / GEN. PARAMETERS						
11C0	Generator Rated MVA	50 to 2000001	1	MVA	F13	2000001
11C2	Generator Rated Power Factor	5 to 100	1	–	F3	100
11C3	Generator Voltage Phase-Phase	100 to 30001	1	V	F1	30001
11C4	Generator Nominal Frequency	0 to 3	1	Hz	F107	0
11C5	Generator Phase Sequence	0 to 2	1	–	F124	0
SYSTEM SETUP / SERIAL START/STOP						
11E0	Serial Start/Stop Initiation	0 to 1	1	–	F105	0
11E1	Startup Initiation Relays (2-5)	1 to 4	1	–	F50	0
11E2	Shutdown Initiation Relays (1-4)	0 to 3	1	–	F50	0
11E3	Serial Start/Stop Events	0 to 1	1	–	F105	0
DIGITAL INPUTS / BREAKER STATUS						
1200	Breaker Status	0 to 1	1	–	F209	1
DIGITAL INPUTS / GENERAL INPUT A						
1210	Assign Digital Input	0 to 7	1	–	F210	0
1211	Asserted Digital Input State	0 to 1	1	–	F131	0
1212	Input Name	0 to 12	1	–	F22	_
1218	Block Input From Online	0 to 5000	1	s	F1	0
1219	General Input A Control	0 to 1	1	–	F105	0
121A	Pulsed Control Relay Dwell Time	0 to 250	1	s	F2	0
121B	Assign Control Relays (1-5)	0 to 4	1	–	F50	0
121C	General Input A Control Events	0 to 1	1	–	F105	0
121D	General Input A Alarm	0 to 2	1	–	F115	0
121E	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
121F	General Input A Alarm Delay	1 to 50000	1	s	F2	50
1220	General Input A Alarm Events	0 to 1	1	–	F105	0
1221	General Input A Trip	0 to 2	1	–	F115	0
1222	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1223	General Input A Trip Delay	1 to 50000	1	s	F2	50
DIGITAL INPUTS / GENERAL INPUT B						
1230	Assign Digital Input	0 to 7	1	–	F210	0
1231	Asserted Digital Input State	0 to 1	1	–	F131	0
1232	Input Name	0 to 12	1	–	F22	_
1238	Block Input From Online	0 to 5000	1	s	F1	0
1239	General Input B Control	0 to 1	1	–	F105	0
123A	Pulsed Control Relay Dwell Time	0 to 250	1	s	F2	0
123B	Assign Control Relays (1-5)	0 to 4	1	–	F50	0
123C	General Input B Control Events	0 to 1	1	–	F105	0
123D	General Input B Alarm	0 to 2	1	–	F115	0
123E	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
123F	General Input B Alarm Delay	1 to 50000	1	s	F2	50
1240	General Input B Alarm Events	0 to 1	1	–	F105	0
1241	General Input B Trip	0 to 2	1	–	F115	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 10 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
1242	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1243	General Input B Trip Delay	1 to 50000	1	s	F2	50
DIGITAL INPUTS / GENERAL INPUT C						
1250	Assign Digital Input	0 to 7	1	–	F210	0
1251	Asserted Digital Input State	0 to 1	1	–	F131	0
1252	Input Name	0 to 12	1	–	F22	_
1258	Block Input From Online	0 to 5000	1	s	F1	0
1259	General Input C Control	0 to 1	1	–	F105	0
125A	Pulsed Control Relay Dwell Time	0 to 250	1	s	F2	0
125B	Assign Control Relays (1-5)	0 to 4	1	–	F50	0
125C	General Input C Control Events	0 to 1	1	–	F105	0
125D	General Input C Alarm	0 to 2	1	–	F115	0
125E	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
125F	General Input C Alarm Delay	1 to 50000	1	s	F2	50
1260	General Input C Alarm Events	0 to 1	1	–	F105	0
1261	General Input C Trip	0 to 2	1	–	F115	0
1262	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1263	General Input C Trip Delay	1 to 50000	1	s	F2	50
DIGITAL INPUTS / GENERAL INPUT D						
1270	Assign Digital Input	0 to 7	1	–	F210	0
1271	Asserted Digital Input State	0 to 1	1	–	F131	0
1272	Input Name	0 to 12	1	–	F22	_
1278	Block Input From Online	0 to 5000	1	s	F1	0
1279	General Input D Control	0 to 1	1	–	F105	0
127A	Pulsed Control Relay Dwell Time	0 to 250	1	s	F2	0
127B	Assign Control Relays (1-5)	0 to 4	1	–	F50	0
127C	General Input D Control Events	0 to 1	1	–	F105	0
127D	General Input D Alarm	0 to 2	1	–	F115	0
127E	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
127F	General Input D Alarm Delay	1 to 50000	1	s	F2	50
1280	General Input D Alarm Events	0 to 1	1	–	F105	0
1281	General Input D Trip	0 to 2	1	–	F115	0
1282	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1283	General Input D Trip Delay	1 to 50000	1	s	F2	50
DIGITAL INPUTS / GENERAL INPUT E						
1290	Assign Digital Input	0 to 7	1	–	F210	0
1291	Asserted Digital Input State	0 to 1	1	–	F131	0
1292	Input Name	0 to 12	1	–	F22	_
1298	Block Input From Online	0 to 5000	1	s	F1	0
1299	General Input E Control	0 to 1	1	–	F105	0
129A	Pulsed Control Relay Dwell Time	0 to 250	1	s	F2	0
129B	Assign Control Relays (1-5)	0 to 4	1	–	F50	0
129C	General Input E Control Events	0 to 1	1	–	F105	0
129D	General Input E Alarm	0 to 2	1	–	F115	0
129E	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
129F	General Input E Alarm Delay	1 to 50000	1	s	F2	50
12A0	General Input E Alarm Events	0 to 1	1	–	F105	0
12A1	General Input E Trip	0 to 2	1	–	F115	0
12A2	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
12A3	General Input E Trip Delay	1 to 50000	1	s	F2	50
DIGITAL INPUTS / GENERAL INPUT F						
12B0	Assign Digital Input	0 to 7	1	–	F210	0
12B1	Asserted Digital Input State	0 to 1	1	–	F131	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 11 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
12B2	Input Name	0 to 12	1	–	F22	_
12B8	Block Input From Online	0 to 5000	1	s	F1	0
12B9	General Input F Control	0 to 1	1	–	F105	0
12BA	Pulsed Control Relay Dwell Time	0 to 250	1	s	F2	0
12BB	Assign Control Relays (1-5)	0 to 4	1	–	F50	0
12BC	General Input F Control Events	0 to 1	1	–	F105	0
12BD	General Input F Alarm	0 to 2	1	–	F115	0
12BE	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
12BF	General Input F Alarm Delay	1 to 50000	1	s	F2	50
12C0	General Input F Alarm Events	0 to 1	1	–	F105	0
12C1	General Input F Trip	0 to 2	1	–	F115	0
12C2	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
12C3	General Input F Trip Delay	1 to 50000	1	s	F2	50
DIGITAL INPUTS / GENERAL INPUT G						
12D0	Assign Digital Input	0 to 7	1	–	F210	0
12D1	Asserted Digital Input State	0 to 1	1	–	F131	0
12D2	Input Name	0 to 12	1	–	F22	_
12D8	Block Input From Online	0 to 5000	1	s	F1	0
12D9	General Input G Control	0 to 1	1	–	F105	0
12DA	Pulsed Control Relay Dwell Time	0 to 250	1	s	F2	0
12DB	Assign Control Relays (1-5)	0 to 4	1	–	F50	0
12DC	General Input G Control Events	0 to 1	1	–	F105	0
12DD	General Input G Alarm	0 to 2	1	–	F115	0
12DE	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
12DF	General Input G Alarm Delay	1 to 50000	1	s	F2	50
12E0	General Input G Alarm Events	0 to 1	1	–	F105	0
12E1	General Input G Trip	0 to 2	1	–	F115	0
12E2	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
12E3	General Input G Trip Delay	1 to 50000	1	s	F2	50
DIGITAL INPUTS / REMOTE RESET						
1300	Assign Digital Input	0 to 7	1	–	F210	0
DIGITAL INPUTS / TEST INPUT						
1310	Assign Digital Input	0 to 7	1	–	F210	0
DIGITAL INPUTS / THERMAL RESET						
1320	Assign Digital Input	0 to 7	1	–	F210	0
DIGITAL INPUTS / DUAL SETPOINTS						
1340	Assign Digital Input	0 to 7	1	–	F210	0
1341	Active Setpoint Group	0 to 1	1	–	F118	0
1342	Edit Setpoint Group	0 to 1	1	–	F118	0
DIGITAL INPUTS / SEQUENTIAL TRIP						
1360	Assign Digital Input	0 to 7	1	–	F210	0
1361	Sequential Trip Type	0 to 1	1	–	F206	0
1362	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1363	Sequential Trip Level	2 to 99	1	× Rated MW	F14	5
1365	Sequential Trip Delay	2 to 1200	1	s	F2	10
DIGITAL INPUTS / FIELD-BREAKER DISCREPANCY						
1380	Assign Digital Input	0 to 7	1	–	F210	0
1381	Field Status Contact	0 to 1	1	–	F109	0
1382	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1383	Field-Breaker Discrepancy Trip Delay	1 to 5000	1	s	F2	10
DIGITAL INPUTS / TACHOMETER						
13A0	Assign Digital Input	0 to 7	1	–	F210	0
13A1	Rated Speed	100 to 3600	1	RPM	F1	3600

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 12 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
13A2	Tachometer Alarm	0 to 2	1	–	F115	0
13A3	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
13A4	Tachometer Alarm Speed	101 to 175	1	%Rated	F1	110
13A5	Tachometer Alarm Delay	1 to 250	1	s	F1	1
13A6	Tachometer Alarm Events	0 to 1	1	–	F105	0
13A7	Tachometer Trip	0 to 2	1	–	F115	0
13A8	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
13A9	Tachometer Trip Speed	101 to 175	1	%Rated	F1	110
13AA	Tachometer Trip Delay	1 to 250	1	s	F1	1
DIGITAL INPUTS / WAVEFORM CAPTURE						
13C0	Assign Digital Input	0 to 7	1	–	F210	0
DIGITAL INPUTS / GROUND SWITCH STATUS						
13D0	Assign Digital Input	0 to 7	1	–	F210	0
13D1	Ground Switch Contact	0 to 1	1	–	F109	0
OUTPUT RELAYS / RELAY RESET MODE						
1400	1 Trip	0 to 1	1	–	F117	0
1401	2 Auxiliary	0 to 1	1	–	F117	0
1402	3 Auxiliary	0 to 1	1	–	F117	0
1403	4 Auxiliary	0 to 1	1	–	F117	0
1404	5 Alarm	0 to 1	1	–	F117	0
1405	6 Service	0 to 1	1	–	F117	0
CURRENT ELEMENTS / OVERCURRENT ALARM						
1500	Overcurrent Alarm	0 to 2	1	–	F115	0
1501	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
1502	Overcurrent Alarm Level	10 to 150	1	× FLA	F3	101
1503	Overcurrent Alarm Delay	1 to 2500	1	s	F2	1
1504	Overcurrent Alarm Events	0 to 1	1	–	F105	0
CURRENT ELEMENTS / OFFLINE OVERCURRENT						
1520	Offline Overcurrent Trip	0 to 2	1	–	F115	0
1521	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1522	Offline Overcurrent Pickup	5 to 100	1	× CT	F3	5
1523	Offline Overcurrent Trip Delay	3 to 99	1	Cycles	F1	5
CURRENT ELEMENTS / INADVERTENT ENERGIZATION						
1540	Inadvertent Energize Trip	0 to 2	1	–	F115	0
1541	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1542	Arming Signal	0 to 1	1	–	F202	0
1543	Inadvertent Energize O/c Pickup	5 to 300	1	× CT	F3	5
1544	Inadvertent Energize Pickup	50 to 99	1	× Rated V	F3	50
CURRENT ELEMENTS / PHASE OVERCURRENT						
1600	Phase Overcurrent Trip	0 to 2	1	–	F115	0
1601	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1602	Enable Voltage Restraint	0 to 1	1	–	F103	0
1603	Phase Overcurrent Pickup	15 to 2000	1	× CT	F3	1000
1604	Curve Shape	0 to 13	1	–	F128	0
1605	FlexCurve™ Trip Time at 1.03 × PU	0 to 65535	1	ms	F1	65535
1606	FlexCurve™ Trip Time at 1.05 × PU	0 to 65535	1	ms	F1	65535
1607	FlexCurve™ Trip Time at 1.10 × PU	0 to 65535	1	ms	F1	65535
1608	FlexCurve™ Trip Time at 1.20 × PU	0 to 65535	1	ms	F1	65535
1609	FlexCurve™ Trip Time at 1.30 × PU	0 to 65535	1	ms	F1	65535
160A	FlexCurve™ Trip Time at 1.40 × PU	0 to 65535	1	ms	F1	65535
160B	FlexCurve™ Trip Time at 1.50 × PU	0 to 65535	1	ms	F1	65535
160C	FlexCurve™ Trip Time at 1.60 × PU	0 to 65535	1	ms	F1	65535
160D	FlexCurve™ Trip Time at 1.70 × PU	0 to 65535	1	ms	F1	65535

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Table 1: 489 Memory Map (Sheet 13 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
160E	FlexCurve™ Trip Time at 1.80 × PU	0 to 65535	1	ms	F1	65535
160F	FlexCurve™ Trip Time at 1.90 × PU	0 to 65535	1	ms	F1	65535
1610	FlexCurve™ Trip Time at 2.00 × PU	0 to 65535	1	ms	F1	65535
1611	FlexCurve™ Trip Time at 2.10 × PU	0 to 65535	1	ms	F1	65535
1612	FlexCurve™ Trip Time at 2.20 × PU	0 to 65535	1	ms	F1	65535
1613	FlexCurve™ Trip Time at 2.30 × PU	0 to 65535	1	ms	F1	65535
1614	FlexCurve™ Trip Time at 2.40 × PU	0 to 65535	1	ms	F1	65535
1615	FlexCurve™ Trip Time at 2.50 × PU	0 to 65535	1	ms	F1	65535
1616	FlexCurve™ Trip Time at 2.60 × PU	0 to 65535	1	ms	F1	65535
1617	FlexCurve™ Trip Time at 2.70 × PU	0 to 65535	1	ms	F1	65535
1618	FlexCurve™ Trip Time at 2.80 × PU	0 to 65535	1	ms	F1	65535
1619	FlexCurve™ Trip Time at 2.90 × PU	0 to 65535	1	ms	F1	65535
161A	FlexCurve™ Trip Time at 3.00 × PU	0 to 65535	1	ms	F1	65535
161B	FlexCurve™ Trip Time at 3.10 × PU	0 to 65535	1	ms	F1	65535
161C	FlexCurve™ Trip Time at 3.20 × PU	0 to 65535	1	ms	F1	65535
161D	FlexCurve™ Trip Time at 3.30 × PU	0 to 65535	1	ms	F1	65535
161E	FlexCurve™ Trip Time at 3.40 × PU	0 to 65535	1	ms	F1	65535
161F	FlexCurve™ Trip Time at 3.50 × PU	0 to 65535	1	ms	F1	65535
1620	FlexCurve™ Trip Time at 3.60 × PU	0 to 65535	1	ms	F1	65535
1621	FlexCurve™ Trip Time at 3.70 × PU	0 to 65535	1	ms	F1	65535
1622	FlexCurve™ Trip Time at 3.80 × PU	0 to 65535	1	ms	F1	65535
1623	FlexCurve™ Trip Time at 3.90 × PU	0 to 65535	1	ms	F1	65535
1624	FlexCurve™ Trip Time at 4.00 × PU	0 to 65535	1	ms	F1	65535
1625	FlexCurve™ Trip Time at 4.10 × PU	0 to 65535	1	ms	F1	65535
1626	FlexCurve™ Trip Time at 4.20 × PU	0 to 65535	1	ms	F1	65535
1627	FlexCurve™ Trip Time at 4.30 × PU	0 to 65535	1	ms	F1	65535
1628	FlexCurve™ Trip Time at 4.40 × PU	0 to 65535	1	ms	F1	65535
1629	FlexCurve™ Trip Time at 4.50 × PU	0 to 65535	1	ms	F1	65535
162A	FlexCurve™ Trip Time at 4.60 × PU	0 to 65535	1	ms	F1	65535
162B	FlexCurve™ Trip Time at 4.70 × PU	0 to 65535	1	ms	F1	65535
162C	FlexCurve™ Trip Time at 4.80 × PU	0 to 65535	1	ms	F1	65535
162D	FlexCurve™ Trip Time at 4.90 × PU	0 to 65535	1	ms	F1	65535
162E	FlexCurve™ Trip Time at 5.00 × PU	0 to 65535	1	ms	F1	65535
162F	FlexCurve™ Trip Time at 5.10 × PU	0 to 65535	1	ms	F1	65535
1630	FlexCurve™ Trip Time at 5.20 × PU	0 to 65535	1	ms	F1	65535
1631	FlexCurve™ Trip Time at 5.30 × PU	0 to 65535	1	ms	F1	65535
1632	FlexCurve™ Trip Time at 5.40 × PU	0 to 65535	1	ms	F1	65535
1633	FlexCurve™ Trip Time at 5.50 × PU	0 to 65535	1	ms	F1	65535
1634	FlexCurve™ Trip Time at 5.60 × PU	0 to 65535	1	ms	F1	65535
1635	FlexCurve™ Trip Time at 5.70 × PU	0 to 65535	1	ms	F1	65535
1636	FlexCurve™ Trip Time at 5.80 × PU	0 to 65535	1	ms	F1	65535
1637	FlexCurve™ Trip Time at 5.90 × PU	0 to 65535	1	ms	F1	65535
1638	FlexCurve™ Trip Time at 6.00 × PU	0 to 65535	1	ms	F1	65535
1639	FlexCurve™ Trip Time at 6.50 × PU	0 to 65535	1	ms	F1	65535
163A	FlexCurve™ Trip Time at 7.00 × PU	0 to 65535	1	ms	F1	65535
163B	FlexCurve™ Trip Time at 7.50 × PU	0 to 65535	1	ms	F1	65535
163C	FlexCurve™ Trip Time at 8.00 × PU	0 to 65535	1	ms	F1	65535
163D	FlexCurve™ Trip Time at 8.50 × PU	0 to 65535	1	ms	F1	65535
163E	FlexCurve™ Trip Time at 9.00 × PU	0 to 65535	1	ms	F1	65535
163F	FlexCurve™ Trip Time at 9.50 × PU	0 to 65535	1	ms	F1	65535
1640	FlexCurve™ Trip Time at 10.0 × PU	0 to 65535	1	ms	F1	65535
1641	FlexCurve™ Trip Time at 10.5 × PU	0 to 65535	1	ms	F1	65535
1642	FlexCurve™ Trip Time at 11.0 × PU	0 to 65535	1	ms	F1	65535

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Table 1: 489 Memory Map (Sheet 14 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
1643	FlexCurve™ Trip Time at 11.5 × PU	0 to 65535	1	ms	F1	65535
1644	FlexCurve™ Trip Time at 12.0 × PU	0 to 65535	1	ms	F1	65535
1645	FlexCurve™ Trip Time at 12.5 × PU	0 to 65535	1	ms	F1	65535
1646	FlexCurve™ Trip Time at 13.0 × PU	0 to 65535	1	ms	F1	65535
1647	FlexCurve™ Trip Time at 13.5 × PU	0 to 65535	1	ms	F1	65535
1648	FlexCurve™ Trip Time at 14.0 × PU	0 to 65535	1	ms	F1	65535
1649	FlexCurve™ Trip Time at 14.5 × PU	0 to 65535	1	ms	F1	65535
164A	FlexCurve™ Trip Time at 15.0 × PU	0 to 65535	1	ms	F1	65535
164B	FlexCurve™ Trip Time at 15.5 × PU	0 to 65535	1	ms	F1	65535
164C	FlexCurve™ Trip Time at 16.0 × PU	0 to 65535	1	ms	F1	65535
164D	FlexCurve™ Trip Time at 16.5 × PU	0 to 65535	1	ms	F1	65535
164E	FlexCurve™ Trip Time at 17.0 × PU	0 to 65535	1	ms	F1	65535
164F	FlexCurve™ Trip Time at 17.5 × PU	0 to 65535	1	ms	F1	65535
1650	FlexCurve™ Trip Time at 18.0 × PU	0 to 65535	1	ms	F1	65535
1651	FlexCurve™ Trip Time at 18.5 × PU	0 to 65535	1	ms	F1	65535
1652	FlexCurve™ Trip Time at 19.0 × PU	0 to 65535	1	ms	F1	65535
1653	FlexCurve™ Trip Time at 19.5 × PU	0 to 65535	1	ms	F1	65535
1654	FlexCurve™ Trip Time at 20.0 × PU	0 to 65535	1	ms	F1	65535
1655	Overcurrent Curve Multiplier	0 to 100000	1	–	F14	100
1657	Overcurrent Curve Reset	0 to 1	1	–	F201	0
1658	Voltage Lower Limit	10 to 60	1	%	F1	10
CURRENT ELEMENTS / NEGATIVE SEQUENCE						
1700	Negative Sequence Alarm	0 to 2	1	–	F115	0
1701	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
1702	Negative Sequence Alarm Pickup	3 to 100	1	%FLA	F1	3
1703	Negative Sequence Alarm Delay	1 to 1000	1	s	F2	50
1704	Negative Sequence Alarm Events	0 to 1	1	–	F105	0
1705	Negative Sequence Overcurrent Trip	0 to 2	1	–	F115	0
1706	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1707	Negative Sequence Overcurrent Trip Pickup	3 to 100	1	%FLA	F1	8
1708	Negative Sequence Overcurrent Constant K	1 to 100	1	–	F1	1
1709	Negative Sequence Overcurrent Maximum Time	10 to 1000	1	s	F1	1000
170A	Negative Sequence Overcurrent Reset Rate	0 to 9999	1	s	F2	2270
CURRENT ELEMENTS / GROUND O/C						
1720	Ground Overcurrent Alarm	0 to 2	1	–	F115	0
1721	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
1722	Ground Overcurrent Alarm Pickup	5 to 2000	1	× CT	F3	20
1723	Ground Overcurrent Alarm Delay	0 to 100	1	Cycles	F1	0
1724	Ground Overcurrent Alarm Events	0 to 1	1	–	F105	0
1725	Ground Overcurrent Trip	0 to 2	1	–	F115	0
1726	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1727	Ground Overcurrent Trip Pickup	5 to 2000	1	× CT	F3	20
1728	Curve Shape	0 to 13	1	–	F128	0
1729	FlexCurve™ Trip Time at 1.03 × PU	0 to 65535	1	ms	F1	65535
172A	FlexCurve™ Trip Time at 1.05 × PU	0 to 65535	1	ms	F1	65535
172B	FlexCurve™ Trip Time at 1.10 × PU	0 to 65535	1	ms	F1	65535
172C	FlexCurve™ Trip Time at 1.20 × PU	0 to 65535	1	ms	F1	65535
172D	FlexCurve™ Trip Time at 1.30 × PU	0 to 65535	1	ms	F1	65535
172E	FlexCurve™ Trip Time at 1.40 × PU	0 to 65535	1	ms	F1	65535
172F	FlexCurve™ Trip Time at 1.50 × PU	0 to 65535	1	ms	F1	65535
1730	FlexCurve™ Trip Time at 1.60 × PU	0 to 65535	1	ms	F1	65535
1731	FlexCurve™ Trip Time at 1.70 × PU	0 to 65535	1	ms	F1	65535
1732	FlexCurve™ Trip Time at 1.80 × PU	0 to 65535	1	ms	F1	65535

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 15 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
1733	FlexCurve™ Trip Time at 1.90 × PU	0 to 65535	1	ms	F1	65535
1734	FlexCurve™ Trip Time at 2.00 × PU	0 to 65535	1	ms	F1	65535
1735	FlexCurve™ Trip Time at 2.10 × PU	0 to 65535	1	ms	F1	65535
1736	FlexCurve™ Trip Time at 2.20 × PU	0 to 65535	1	ms	F1	65535
1737	FlexCurve™ Trip Time at 2.30 × PU	0 to 65535	1	ms	F1	65535
1738	FlexCurve™ Trip Time at 2.40 × PU	0 to 65535	1	ms	F1	65535
1739	FlexCurve™ Trip Time at 2.50 × PU	0 to 65535	1	ms	F1	65535
173A	FlexCurve™ Trip Time at 2.60 × PU	0 to 65535	1	ms	F1	65535
173B	FlexCurve™ Trip Time at 2.70 × PU	0 to 65535	1	ms	F1	65535
173C	FlexCurve™ Trip Time at 2.80 × PU	0 to 65535	1	ms	F1	65535
173D	FlexCurve™ Trip Time at 2.90 × PU	0 to 65535	1	ms	F1	65535
173E	FlexCurve™ Trip Time at 3.00 × PU	0 to 65535	1	ms	F1	65535
173F	FlexCurve™ Trip Time at 3.10 × PU	0 to 65535	1	ms	F1	65535
1740	FlexCurve™ Trip Time at 3.20 × PU	0 to 65535	1	ms	F1	65535
1741	FlexCurve™ Trip Time at 3.30 × PU	0 to 65535	1	ms	F1	65535
1742	FlexCurve™ Trip Time at 3.40 × PU	0 to 65535	1	ms	F1	65535
1743	FlexCurve™ Trip Time at 3.50 × PU	0 to 65535	1	ms	F1	65535
1744	FlexCurve™ Trip Time at 3.60 × PU	0 to 65535	1	ms	F1	65535
1745	FlexCurve™ Trip Time at 3.70 × PU	0 to 65535	1	ms	F1	65535
1746	FlexCurve™ Trip Time at 3.80 × PU	0 to 65535	1	ms	F1	65535
1747	FlexCurve™ Trip Time at 3.90 × PU	0 to 65535	1	ms	F1	65535
1748	FlexCurve™ Trip Time at 4.00 × PU	0 to 65535	1	ms	F1	65535
1749	FlexCurve™ Trip Time at 4.10 × PU	0 to 65535	1	ms	F1	65535
174A	FlexCurve™ Trip Time at 4.20 × PU	0 to 65535	1	ms	F1	65535
174B	FlexCurve™ Trip Time at 4.30 × PU	0 to 65535	1	ms	F1	65535
174C	FlexCurve™ Trip Time at 4.40 × PU	0 to 65535	1	ms	F1	65535
174D	FlexCurve™ Trip Time at 4.50 × PU	0 to 65535	1	ms	F1	65535
174E	FlexCurve™ Trip Time at 4.60 × PU	0 to 65535	1	ms	F1	65535
174F	FlexCurve™ Trip Time at 4.70 × PU	0 to 65535	1	ms	F1	65535
1750	FlexCurve™ Trip Time at 4.80 × PU	0 to 65535	1	ms	F1	65535
1751	FlexCurve™ Trip Time at 4.90 × PU	0 to 65535	1	ms	F1	65535
1752	FlexCurve™ Trip Time at 5.00 × PU	0 to 65535	1	ms	F1	65535
1753	FlexCurve™ Trip Time at 5.10 × PU	0 to 65535	1	ms	F1	65535
1754	FlexCurve™ Trip Time at 5.20 × PU	0 to 65535	1	ms	F1	65535
1755	FlexCurve™ Trip Time at 5.30 × PU	0 to 65535	1	ms	F1	65535
1756	FlexCurve™ Trip Time at 5.40 × PU	0 to 65535	1	ms	F1	65535
1757	FlexCurve™ Trip Time at 5.50 × PU	0 to 65535	1	ms	F1	65535
1758	FlexCurve™ Trip Time at 5.60 × PU	0 to 65535	1	ms	F1	65535
1759	FlexCurve™ Trip Time at 5.70 × PU	0 to 65535	1	ms	F1	65535
175A	FlexCurve™ Trip Time at 5.80 × PU	0 to 65535	1	ms	F1	65535
175B	FlexCurve™ Trip Time at 5.90 × PU	0 to 65535	1	ms	F1	65535
175C	FlexCurve™ Trip Time at 6.00 × PU	0 to 65535	1	ms	F1	65535
175D	FlexCurve™ Trip Time at 6.50 × PU	0 to 65535	1	ms	F1	65535
175E	FlexCurve™ Trip Time at 7.00 × PU	0 to 65535	1	ms	F1	65535
175F	FlexCurve™ Trip Time at 7.50 × PU	0 to 65535	1	ms	F1	65535
1760	FlexCurve™ Trip Time at 8.00 × PU	0 to 65535	1	ms	F1	65535
1761	FlexCurve™ Trip Time at 8.50 × PU	0 to 65535	1	ms	F1	65535
1762	FlexCurve™ Trip Time at 9.00 × PU	0 to 65535	1	ms	F1	65535
1763	FlexCurve™ Trip Time at 9.50 × PU	0 to 65535	1	ms	F1	65535
1764	FlexCurve™ Trip Time at 10.0 × PU	0 to 65535	1	ms	F1	65535
1765	FlexCurve™ Trip Time at 10.5 × PU	0 to 65535	1	ms	F1	65535
1766	FlexCurve™ Trip Time at 11.0 × PU	0 to 65535	1	ms	F1	65535
1767	FlexCurve™ Trip Time at 11.5 × PU	0 to 65535	1	ms	F1	65535

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Table 1: 489 Memory Map (Sheet 16 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
1768	FlexCurve™ Trip Time at 12.0 × PU	0 to 65535	1	ms	F1	65535
1769	FlexCurve™ Trip Time at 12.5 × PU	0 to 65535	1	ms	F1	65535
176A	FlexCurve™ Trip Time at 13.0 × PU	0 to 65535	1	ms	F1	65535
176B	FlexCurve™ Trip Time at 13.5 × PU	0 to 65535	1	ms	F1	65535
176C	FlexCurve™ Trip Time at 14.0 × PU	0 to 65535	1	ms	F1	65535
176D	FlexCurve™ Trip Time at 14.5 × PU	0 to 65535	1	ms	F1	65535
176E	FlexCurve™ Trip Time at 15.0 × PU	0 to 65535	1	ms	F1	65535
176F	FlexCurve™ Trip Time at 15.5 × PU	0 to 65535	1	ms	F1	65535
1770	FlexCurve™ Trip Time at 16.0 × PU	0 to 65535	1	ms	F1	65535
1771	FlexCurve™ Trip Time at 16.5 × PU	0 to 65535	1	ms	F1	65535
1772	FlexCurve™ Trip Time at 17.0 × PU	0 to 65535	1	ms	F1	65535
1773	FlexCurve™ Trip Time at 17.5 × PU	0 to 65535	1	ms	F1	65535
1774	FlexCurve™ Trip Time at 18.0 × PU	0 to 65535	1	ms	F1	65535
1775	FlexCurve™ Trip Time at 18.5 × PU	0 to 65535	1	ms	F1	65535
1776	FlexCurve™ Trip Time at 19.0 × PU	0 to 65535	1	ms	F1	65535
1777	FlexCurve™ Trip Time at 19.5 × PU	0 to 65535	1	ms	F1	65535
1778	FlexCurve™ Trip Time at 20.0 × PU	0 to 65535	1	ms	F1	65535
1779	Overcurrent Curve Multiplier	0 to 100000	1	–	F14	100
177B	Overcurrent Curve Reset	0 to 1	1	–	F201	0
CURRENT ELEMENTS / PHASE DIFFERENTIAL						
17E0	Phase Differential Trip	0 to 2	1	–	F115	0
17E1	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
17E2	Differential Trip Minimum Pickup	5 to 100	1	× CT	F3	10
17E3	Differential Trip Slope 1	1 to 100	1	%	F1	10
17E4	Differential Trip Slope 2	1 to 100	1	%	F1	20
17E5	Differential Trip Delay	0 to 100	1	cycles	F1	0
CURRENT ELEMENTS / GROUND DIRECTIONAL						
1800	Supervise With Digital Input	0 to 1	1	–	F103	1
1801	Ground Directional MTA	0 to 3	1	–	F217	0
1802	Ground Directional Alarm	0 to 2	1	–	F115	0
1803	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
1804	Ground Directional Alarm Pickup	5 to 2000	1	× CT	F3	5
1805	Ground Directional Alarm Delay	1 to 1200	1	s	F2	30
1806	Ground Directional Alarm Events	0 to 1	1	–	F105	0
1807	Ground Directional Trip	0 to 2	1	–	F115	0
1808	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1809	Ground Directional Trip Pickup	5 to 2000	1	× CT	F3	5
180A	Ground Directional Trip Delay	1 to 1200	1	s	F2	30
CURRENT ELEMENTS / HIGH-SET PHASE OVERCURRENT						
1830	High-Set Phase Overcurrent Trip	0 to 2	1	–	F115	0
1831	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
1832	High-Set Phase Overcurrent Pickup	15 to 2000	1	× CT	F3	500
1833	High-Set Phase Overcurrent Delay	0 to 10000	1	s	F3	100
VOLTAGE ELEMENTS / UNDERVOLTAGE						
2000	Undervoltage Alarm	0 to 2	1	–	F115	0
2001	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2002	Undervoltage Alarm Pickup	50 to 99	1	× Rated	F3	85
2003	Undervoltage Alarm Delay	2 to 1200	1	s	F2	30
2004	Undervoltage Alarm Events	0 to 1	1	–	F105	0
2005	Undervoltage Trip	0 to 2	1	–	F115	0
2006	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2007	Undervoltage Trip Pickup	50 to 99	1	× Rated	F3	80
2008	Undervoltage Trip Delay	2 to 100	1	s	F2	10

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Table 1: 489 Memory Map (Sheet 17 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
2009	Undervoltage Curve Reset Rate	0 to 9999	1	s	F2	14
200A	Undervoltage Curve Element	0 to 1	1	–	F208	0
VOLTAGE ELEMENTS / OVERVOLTAGE						
2020	Overvoltage Alarm	0 to 2	1	–	F115	0
2021	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2022	Overvoltage Alarm Pickup	101 to 150	1	× Rated	F3	115
2023	Overvoltage Alarm Delay	1 to 1200	1	s	F2	30
2024	Overvoltage Alarm Events	0 to 1	1	–	F105	0
2025	Overvoltage Trip	0 to 2	1	–	F115	0
2026	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2027	Overvoltage Trip Pickup	101 to 150	1	× Rated	F3	120
2028	Overvoltage Trip Delay	1 to 100	1	s	F2	10
2029	Overvoltage Curve Reset Rate	0 to 9999	1	s	F2	14
202A	Overvoltage Curve Element	0 to 1	1	–	F208	0
VOLTAGE ELEMENTS / VOLTS/HERTZ						
2040	Volts/Hertz Alarm	0 to 2	1	–	F115	0
2041	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2042	Volts/Hertz Alarm Pickup	50 to 199	1	× Nominal	F3	100
2043	Volts/Hertz Alarm Delay	1 to 1500	1	s	F2	30
2044	Volts/Hertz Alarm Events	0 to 1	1	–	F105	0
2045	Volts/Hertz Trip	0 to 2	1	–	F115	0
2046	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2047	Volts/Hertz Trip Pickup	50 to 199	1	× Nominal	F3	100
2048	Volts/Hertz Trip Delay	1 to 1500	1	s	F2	10
2049	Volts/Hertz Curve Reset Rate	0 to 9999	1	s	F2	14
204A	Volts/Hertz Trip Element	0 to 3	1	–	F211	0
VOLTAGE ELEMENTS / PHASE REVERSAL						
2060	Phase Reversal Trip	0 to 2	1	–	F115	0
2061	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
VOLTAGE ELEMENTS / UNDERFREQUENCY						
2080	Block Underfrequency From Online	0 to 5	1	s	F1	1
2081	Voltage Level Cutoff	50 to 99	1	× Rated	F3	50
2082	Underfrequency Alarm	0 to 2	1	–	F115	0
2083	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2084	Underfrequency Alarm Level	2000 to 6000	1	Hz	F3	5950
2085	Underfrequency Alarm Delay	1 to 50000	1	s	F2	50
2086	Underfrequency Alarm Events	0 to 1	1	–	F105	0
2087	Underfrequency Trip	0 to 2	1	–	F115	0
2088	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2089	Underfrequency Trip Level 1	2000 to 6000	1	Hz	F3	5950
208A	Underfrequency Trip Delay 1	1 to 50000	1	s	F2	600
208B	Underfrequency Trip Level 2	2000 to 6000	1	Hz	F3	5800
208C	Underfrequency Trip Delay 2	1 to 50000	1	s	F2	300
VOLTAGE ELEMENTS / OVERFREQUENCY						
20A0	Block Overfrequency From Online	0 to 5	1	s	F1	1
20A1	Voltage Level Cutoff	50 to 99	1	× Rated	F3	50
20A2	Overfrequency Alarm	0 to 2	1	–	F115	0
20A3	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
20A4	Overfrequency Alarm Level	2501 to 7000	1	Hz	F3	6050
20A5	Overfrequency Alarm Delay	1 to 50000	1	s	F2	50
20A6	Overfrequency Alarm Events	0 to 1	1	–	F105	0
20A7	Overfrequency Trip	0 to 2	1	–	F115	0
20A8	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1

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Table 1: 489 Memory Map (Sheet 18 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
20A9	Overfrequency Trip Level 1	2501 to 7000	1	Hz	F3	6050
20AA	Overfrequency Trip Delay 1	1 to 50000	1	s	F2	600
20AB	Overfrequency Trip Level 2	2501 to 7000	1	Hz	F3	6200
20AC	Overfrequency Trip Delay 2	1 to 50000	1	s	F2	300
VOLTAGE ELEMENTS / NEUTRAL OVERVOLTAGE (FUNDAMENTAL)						
20C0	Neutral Overvoltage Alarm	0 to 2	1	–	F115	0
20C1	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
20C2	Neutral Overvoltage Alarm Level	20 to 1000	1	Vsec.	F2	30
20C3	Neutral Overvoltage Alarm Delay	1 to 1200	1	s	F2	10
20C4	Neutral Overvoltage Alarm Events	0 to 1	1	–	F105	0
20C5	Neutral Overvoltage Trip	0 to 2	1	–	F115	0
20C6	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
20C7	Neutral Overvoltage Trip Level	20 to 1000	1	V	F2	50
20C8	Neutral Overvoltage Trip Delay	1 to 1200	1	s	F2	10
20C9	Supervise With Digital Input	0 to 1	1	–	F103	0
20CA	Neutral Overvoltage Curve Reset Rate	0 to 9999	1	s	F2	0
20CB	Neutral Overvoltage Trip Element	0 to 1	1	–	F208	1
VOLTAGE ELEMENTS / NEUTRAL UNDERVOLTAGE (3rd HARMONIC)						
20E0	Low Power Blocking Level	2 to 99	1	× Rated MW	F14	5
20E2	Low Voltage Blocking Level	50 to 100	1	× Rated	F3	75
20E3	Neutral Undervoltage Alarm	0 to 2	1	–	F115	0
20E4	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
20E5	Neutral Undervoltage Alarm Level	5 to 200	1	V	F2	5
20E6	Neutral Undervoltage Alarm Delay	5 to 120	1	s	F1	30
20E7	Neutral Undervoltage Alarm Events	0 to 1	1	–	F105	0
20E8	Neutral Undervoltage Trip	0 to 2	1	–	F115	0
20E9	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
20EA	Neutral Undervoltage Trip Level	5 to 200	1	V	F2	10
20EB	Neutral Undervoltage Trip Delay	5 to 120	1	s	F1	30
VOLTAGE ELEMENTS / LOSS OF EXCITATION						
2100	Enable Voltage Supervision	0 to 1	1	–	F103	0
2101	Voltage Level	70 to 100	1	× rated	F3	70
2102	Circle 1 Trip	0 to 2	1	–	F115	0
2103	Assign Circle 1 Trip Relays (1-4)	0 to 3	1	–	F50	1
2104	Circle 1 Diameter	25 to 3000	1	Ω s	F2	250
2105	Circle 1 Offset	10 to 3000	1	Ω s	F2	25
2106	Circle 1 Trip Delay	1 to 100	1	s	F2	50
2107	Circle 2 Trip	0 to 2	1	–	F115	0
2108	Assign Circle 2 Trip Relays (1-4)	0 to 3	1	–	F50	1
2109	Circle 2 Diameter	25 to 3000	1	Ω s	F2	350
210A	Circle 2 Offset	10 to 3000	1	Ω s	F2	25
210B	Circle 2 Trip Delay	1 to 100	1	s	F2	50
VOLTAGE ELEMENTS / DISTANCE ELEMENT						
2130	Step Up Transformer Setup	0 to 1	1	–	F219	0
2131	Fuse Failure Supervision	0 to 1	1	–	F105	0
2132	Zone 1 Trip	0 to 2	1	–	F115	0
2133	Assign Zone 1 Trip Relays (1-4)	0 to 3	1	–	F50	1
2134	Zone 1 Reach	1 to 5000	1	Ω s	F2	100
2135	Zone 1 Angle	50 to 85	1	°	F1	75
2136	Zone 1 Trip Delay	0 to 1500	1	s	F2	4
2137	Zone 2 Trip	0 to 2	1	–	F115	0
2138	Assign Zone 2 Trip Relays (1-4)	0 to 3	1	–	F50	1
2139	Zone 2 Reach	1 to 5000	1	Ω s	F2	100

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Table 1: 489 Memory Map (Sheet 19 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
213A	Zone 2 Angle	50 to 85	1	°	F1	75
213B	Zone 2 Trip Delay	0 to 1500	1	s	F2	20
POWER ELEMENTS / REACTIVE POWER						
2200	Block Mvar Element From Online	0 to 5000	1	s	F1	1
2201	Reactive Power Alarm	0 to 2	1	–	F115	0
2202	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2203	Positive Mvar Alarm Level [3]	2 to 201	1	x rated	F14	85
2205	Negative Mvar Alarm Level [3]	2 to 201	1	x rated	F14	85
2207	Negative Mvar Alarm Delay	2 to 1200	1	s	F2	10
2208	Reactive Power Alarm Events	0 to 1	1	–	F105	0
2209	Reactive Power Trip	0 to 2	1	–	F115	0
220A	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
220B	Positive Mvar Trip Level [3]	2 to 201	1	Mvar	F14	80
220D	Negative Mvar Trip Level [3]	2 to 201	1	Mvar	F14	80
220F	Negative Mvar Trip Delay	2 to 1200	1	s	F2	10
2210	Positive Mvar Trip Delay	2 to 1200	1	s	F2	200
2211	Positive Mvar Alarm Delay	2 to 1200	1	s	F2	100
POWER ELEMENTS / REVERSE POWER						
2240	Block Reverse Power From Online	0 to 5000	1	s	F1	1
2241	Reverse Power Alarm	0 to 2	1	–	F115	0
2242	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2243	Reverse Power Alarm Level	2 to 99	1	× Rated	F14	5
2245	Reverse Power Alarm Delay	2 to 1200	1	s	F2	100
2246	Reverse Power Alarm Events	0 to 1	1	–	F105	0
2247	Reverse Power Trip	0 to 2	1	–	F115	0
2248	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2249	Reverse Power Trip Level	2 to 99	1	× Rated	F14	5
224B	Reverse Power Trip Delay	2 to 1200	1	s	F2	200
POWER ELEMENTS / LOW FORWARD POWER						
2280	Block Low Forward Power From Online	0 to 15000	1	s	F1	0
2281	Low Forward Power Alarm	0 to 2	1	–	F115	0
2282	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2283	Low Forward Power Alarm Level	2 to 99	1	× Rated MW	F14	5
2285	Low Forward Power Alarm Delay	2 to 1200	1	s	F2	100
2286	Low Forward Power Alarm Events	0 to 1	1	–	F105	0
2287	Low Forward Power Trip	0 to 2	1	–	F115	0
2288	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2289	Low Forward Power Trip Level	2 to 99	1	× Rated MW	F14	5
228B	Low Forward Power Trip Delay	2 to 1200	1	s	F2	200
RTD TEMPERATURE / RTD TYPES						
2400	Stator RTD Type	0 to 3	1	–	F120	0
2401	Bearing RTD Type	0 to 3	1	–	F120	0
2402	Ambient RTD Type	0 to 3	1	–	F120	0
2403	Other RTD Type	0 to 3	1	–	F120	0
RTD TEMPERATURE / RTD #1						
2420	RTD #1 Application	0 to 4	1	–	F121	1
2421	RTD #1 Alarm	0 to 2	1	–	F115	0
2422	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2423	RTD #1 Alarm Temperature	1 to 250	1	°C	F1	130
2424	RTD #1 Alarm Events	0 to 1	1	–	F105	0
2425	RTD #1 Trip	0 to 2	1	–	F115	0
2426	RTD #1 Trip Voting	1 to 12	1	–	F122	1
2427	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 20 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
2428	RTD #1 Trip Temperature	1 to 250	1	°C	F1	155
2429	RTD #1 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #2						
2460	RTD #2 Application	0 to 4	1	–	F121	1
2461	RTD #2 Alarm	0 to 2	1	–	F115	0
2462	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2463	RTD #2 Alarm Temperature	1 to 250	1	°C	F1	130
2464	RTD #2 Alarm Events	0 to 1	1	–	F105	0
2465	RTD #2 Trip	0 to 2	1	–	F115	0
2466	RTD #2 Trip Voting	1 to 12	1	–	F122	2
2467	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2468	RTD #2 Trip Temperature	1 to 250	1	°C	F1	155
2469	RTD #2 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #3						
24A0	RTD #3 Application	0 to 4	1	–	F121	1
24A1	RTD #3 Alarm	0 to 2	1	–	F115	0
24A2	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
24A3	RTD #3 Alarm Temperature	1 to 250	1	°C	F1	130
24A4	RTD #3 Alarm Events	0 to 1	1	–	F105	0
24A5	RTD #3 Trip	0 to 2	1	–	F115	0
24A6	RTD #3 Trip Voting	1 to 12	1	–	F122	3
24A7	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
24A8	RTD #3 Trip Temperature	1 to 250	1	°C	F1	155
24A9	RTD #3 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #4						
24E0	RTD #4 Application	0 to 4	1	–	F121	1
24E1	RTD #4 Alarm	0 to 2	1	–	F115	0
24E2	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
24E3	RTD #4 Alarm Temperature	1 to 250	1	°C	F1	130
24E4	RTD #4 Alarm Events	0 to 1	1	–	F105	0
24E5	RTD #4 Trip	0 to 2	1	–	F115	0
24E6	RTD #4 Trip Voting	1 to 12	1	–	F122	4
24E7	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
24E8	RTD #4 Trip Temperature	1 to 250	1	°C	F1	155
24E9	RTD #4 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #5						
2520	RTD #5 Application	0 to 4	1	–	F121	1
2521	RTD #5 Alarm	0 to 2	1	–	F115	0
2522	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2523	RTD #5 Alarm Temperature	1 to 250	1	°C	F1	130
2524	RTD #5 Alarm Events	0 to 1	1	–	F105	0
2525	RTD #5 Trip	0 to 2	1	–	F115	0
2526	RTD #5 Trip Voting	1 to 12	1	–	F122	5
2527	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2528	RTD #5 Trip Temperature	1 to 250	1	°C	F1	155
2529	RTD #5 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #6						
2560	RTD #6 Application	0 to 4	1	–	F121	1
2561	RTD #6 Alarm	0 to 2	1	–	F115	0
2562	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2563	RTD #6 Alarm Temperature	1 to 250	1	°C	F1	130
2564	RTD #6 Alarm Events	0 to 1	1	–	F105	0
2565	RTD #6 Trip	0 to 2	1	–	F115	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 21 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
2566	RTD #6 Trip Voting	1 to 12	1	–	F122	6
2567	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2568	RTD #6 Trip Temperature	1 to 250	1	°C	F1	155
2569	RTD #6 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #7						
25A0	RTD #7 Application	0 to 4	1	–	F121	2
25A1	RTD #7 Alarm	0 to 2	1	–	F115	0
25A2	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
25A3	RTD #7 Alarm Temperature	1 to 250	1	°C	F1	80
25A4	RTD #7 Alarm Events	0 to 1	1	–	F105	0
25A5	RTD #7 Trip	0 to 2	1	–	F115	0
25A6	RTD #7 Trip Voting	1 to 12	1	–	F122	7
25A7	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
25A8	RTD #7 Trip Temperature	1 to 250	1	°C	F1	90
25A9	RTD #7 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #8						
25E0	RTD #8 Application	0 to 4	1	–	F121	2
25E1	RTD #8 Alarm	0 to 2	1	–	F115	0
25E2	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
25E3	RTD #8 Alarm Temperature	1 to 250	1	°C	F1	80
25E4	RTD #8 Alarm Events	0 to 1	1	–	F105	0
25E5	RTD #8 Trip	0 to 2	1	–	F115	0
25E6	RTD #8 Trip Voting	1 to 12	1	–	F122	8
25E7	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
25E8	RTD #8 Trip Temperature	1 to 250	1	°C	F1	90
25E9	RTD #8 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #9						
2620	RTD #9 Application	0 to 4	1	–	F121	2
2621	RTD #9 Alarm	0 to 2	1	–	F115	0
2622	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2623	RTD #9 Alarm Temperature	1 to 250	1	°C	F1	80
2624	RTD #9 Alarm Events	0 to 1	1	–	F105	0
2625	RTD #9 Trip	0 to 2	1	–	F115	0
2626	RTD #9 Trip Voting	1 to 12	1	–	F122	9
2627	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2628	RTD #9 Trip Temperature	1 to 250	1	°C	F1	90
2629	RTD #9 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #10						
2660	RTD #10 Application	0 to 4	1	–	F121	2
2661	RTD #10 Alarm	0 to 2	1	–	F115	0
2662	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2663	RTD #10 Alarm Temperature	1 to 250	1	°C	F1	80
2664	RTD #10 Alarm Events	0 to 1	1	–	F105	0
2665	RTD #10 Trip	0 to 2	1	–	F115	0
2666	RTD #10 Trip Voting	1 to 12	1	–	F122	10
2667	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2668	RTD #10 Trip Temperature	1 to 250	1	°C	F1	90
2669	RTD #10 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #11						
26A0	RTD #11 Application	0 to 4	1	–	F121	4
26A1	RTD #11 Alarm	0 to 2	1	–	F115	0
26A2	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
26A3	RTD #11 Alarm Temperature	1 to 250	1	°C	F1	80

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 22 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
26A4	RTD #11 Alarm Events	0 to 1	1	–	F105	0
26A5	RTD #11 Trip	0 to 2	1	–	F115	0
26A6	RTD #11 Trip Voting	1 to 12	1	–	F122	11
26A7	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
26A8	RTD #11 Trip Temperature	1 to 250	1	°C	F1	90
26A9	RTD #11 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / RTD #12						
26E0	RTD #12 Application	0 to 4	1	–	F121	3
26E1	RTD #12 Alarm	0 to 2	1	–	F115	0
26E2	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
26E3	RTD #12 Alarm Temperature	1 to 250	1	°C	F1	60
26E4	RTD #12 Alarm Events	0 to 1	1	–	F105	0
26E5	RTD #12 Trip	0 to 2	1	–	F115	0
26E6	RTD #12 Trip Voting	1 to 12	1	–	F122	12
26E7	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
26E8	RTD #12 Trip Temperature	1 to 250	1	°C	F1	80
26E9	RTD #12 Name	0 to 8	1	–	F22	_
RTD TEMPERATURE / OPEN RTD SENSOR						
2720	Open RTD Sensor Alarm	0 to 2	1	–	F115	0
2721	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2722	Open RTD Sensor Alarm Events	0 to 1	1	–	F105	0
RTD TEMPERATURE / RTD SHORT/LOW TEMPERATURE						
2740	RTD Short/Low Temperature Alarm	0 to 2	1	–	F115	0
2741	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2742	RTD Short/Low Temperature Alarm Events	0 to 1	1	–	F105	0
THERMAL MODEL / MODEL SETUP						
2800	Enable Thermal Model	0 to 1	1	–	F103	0
2801	Overload Pickup Level	101 to 125	1	× FLA	F3	101
2802	Unbalance Bias K Factor	0 to 12	1	–	F1	0
2803	Cool Time Constant Online	0 to 500	1	min	F1	15
2804	Cool Time Constant Offline	0 to 500	1	min	F1	30
2805	Hot/Cold Safe Stall Ratio	1 to 100	1	–	F3	100
2806	Enable RTD Biasing	0 to 1	1	–	F103	0
2807	RTD Bias Minimum	0 to 250	1	°C	F1	40
2808	RTD Bias Center Point	0 to 250	1	°C	F1	130
2809	RTD Bias Maximum	0 to 250	1	°C	F1	155
280A	Select Curve Style	0 to 2	1	–	F142	0
280B	Standard Overload Curve Number	1 to 15	1	–	F1	4
280C	Time to Trip at 1.01 × FLA	5 to 999999	1	s	F10	5
280E	Time to Trip at 1.05 × FLA	5 to 999999	1	s	F10	5
2810	Time to Trip at 1.10 × FLA	5 to 999999	1	s	F10	5
2812	Time to Trip at 1.20 × FLA	5 to 999999	1	s	F10	5
2814	Time to Trip at 1.30 × FLA	5 to 999999	1	s	F10	5
2816	Time to Trip at 1.40 × FLA	5 to 999999	1	s	F10	5
2818	Time to Trip at 1.50 × FLA	5 to 999999	1	s	F10	5
281A	Time to Trip at 1.75 × FLA	5 to 999999	1	s	F10	5
281C	Time to Trip at 2.00 × FLA	5 to 999999	1	s	F10	5
281E	Time to Trip at 2.25 × FLA	5 to 999999	1	s	F10	5
2820	Time to Trip at 2.50 × FLA	5 to 999999	1	s	F10	5
2822	Time to Trip at 2.75 × FLA	5 to 999999	1	s	F10	5
2824	Time to Trip at 3.00 × FLA	5 to 999999	1	s	F10	5
2826	Time to Trip at 3.25 × FLA	5 to 999999	1	s	F10	5
2828	Time to Trip at 3.50 × FLA	5 to 999999	1	s	F10	5

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 23 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
282A	Time to Trip at 3.75 × FLA	5 to 999999	1	s	F10	5
282C	Time to Trip at 4.00 × FLA	5 to 999999	1	s	F10	5
282E	Time to Trip at 4.25 × FLA	5 to 999999	1	s	F10	5
2830	Time to Trip at 4.50 × FLA	5 to 999999	1	s	F10	5
2832	Time to Trip at 4.75 × FLA	5 to 999999	1	s	F10	5
2834	Time to Trip at 5.00 × FLA	5 to 999999	1	s	F10	5
2836	Time to Trip at 5.50 × FLA	5 to 999999	1	s	F10	5
2838	Time to Trip at 6.00 × FLA	5 to 999999	1	s	F10	5
283A	Time to Trip at 6.50 × FLA	5 to 999999	1	s	F10	5
283C	Time to Trip at 7.00 × FLA	5 to 999999	1	s	F10	5
283E	Time to Trip at 7.50 × FLA	5 to 999999	1	s	F10	5
2840	Time to Trip at 8.00 × FLA	5 to 999999	1	s	F10	5
2842	Time to Trip at 10.0 × FLA	5 to 999999	1	s	F10	5
2844	Time to Trip at 15.0 × FLA	5 to 999999	1	s	F10	5
2846	Time to Trip at 20.0 × FLA	5 to 999999	1	s	F10	5
2848	Minimum Allowable Voltage	70 to 95	1	%	F1	80
2849	Stall Current at Minimum Voltage	200 to 1500	1	× FLA	F3	480
284A	Safe Stall Time at Minimum Voltage	5 to 9999	1	s	F2	200
284B	Acceleration Intersect at Minimum Voltage	200 to 1500	1	× FLA	F3	380
284C	Stall Current at 100% Voltage	200 to 1500	1	× FLA	F3	600
284D	Safe Stall Time at 100% Voltage	5 to 9999	1	s	F2	100
284E	Acceleration Intersect at 100% Voltage	200 to 1500	1	× FLA	F3	500
THERMAL MODEL / THERMAL ELEMENTS						
2900	Thermal Model Alarm	0 to 2	1	–	F115	0
2901	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2902	Thermal Alarm Level	10 to 100	1	%Used	F1	75
2903	Thermal Model Alarm Events	0 to 1	1	–	F105	0
2904	Thermal Model Trip	0 to 2	1	–	F115	0
2905	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
MONITORING / TRIP COUNTER						
2A00	Trip Counter Alarm	0 to 2	1	–	F115	0
2A01	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2A02	Trip Counter Alarm Level	1 to 50000	1	Trips	F1	25
2A03	Trip Counter Alarm Events	0 to 1	1	–	F105	0
MONITORING / BREAKER FAILURE						
2A20	Breaker Failure Alarm	0 to 2	1	–	F115	0
2A21	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2A22	Breaker Failure Level	5 to 2000	1	× CT	F3	100
2A23	Breaker Failure Delay	10 to 1000	10	ms	F1	100
2A24	Breaker Failure Alarm Events	0 to 1	1	–	F105	0
MONITORING / TRIP COIL MONITOR						
2A30	Trip Coil Monitor Alarm	0 to 2	1	–	F115	0
2A31	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2A32	Trip Coil Monitor Alarm Events	0 to 1	1	–	F105	0
MONITORING / VT FUSE FAILURE						
2A50	VT Fuse Failure Alarm	0 to 2	1	–	F115	0
2A51	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2A52	VT Fuse Failure Alarm Events	0 to 1	1	–	F105	0
MONITORING / CURRENT DEMAND						
2A60	Current Demand Period	5 to 90	1	min	F1	15
2A61	Current Demand Alarm	0 to 2	1	A	F115	0
2A62	Assign Alarm Relays (2-5)	1 to 4	1	A	F50	16
2A63	Current Demand Limit	10 to 2000	1	× FLA	F14	125

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 24 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
2A65	Current Demand Alarm Events	0 to 1	1	A	F105	0
MONITORING / MW DEMAND						
2A70	MW Demand Period	5 to 90	1	min	F1	15
2A71	MW Demand Alarm	0 to 2	1	–	F115	0
2A72	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2A73	MW Demand Limit	10 to 200	1	× Rated	F14	125
2A75	MW Demand Alarm Events	0 to 1	1	–	F105	0
MONITORING / Mvar DEMAND						
2A80	Mvar Demand Period	5 to 90	1	min	F1	15
2A81	Mvar Demand Alarm	0 to 2	1	–	F115	0
2A82	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2A83	Mvar Demand Limit	10 to 200	1	× Rated	F14	125
2A85	Mvar Demand Alarm Events	0 to 1	1	–	F105	0
MONITORING / MVA DEMAND						
2A90	MVA Demand Period	5 to 90	1	min	F1	15
2A91	MVA Demand Alarm	0 to 2	1	–	F115	0
2A92	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2A93	MVA Demand Limit	10 to 200	1	× Rated	F14	125
2A95	MVA Demand Alarm Events	0 to 1	1	–	F105	0
MONITORING / PULSE OUTPUT						
2AB0	Positive kWh Pulse Output Relays (2-5)	1 to 4	1	–	F50	0
2AB1	Positive kWh Pulse Output Interval	1 to 50000	1	–	F1	10
2AB2	Positive kvarh Pulse Output Relays (2-5)	1 to 4	1	–	F50	0
2AB3	Positive kvarh Pulse Output Interval	1 to 50000	1	–	F1	10
2AB4	Negative kvarh Pulse Output Relays (2-5)	1 to 4	1	–	F50	0
2AB5	Negative kvarh Pulse Output Interval	1 to 50000	1	–	F1	10
2AB6	Pulse Width	200 to 1000	1	–	F1	200
MONITORING / RUNNING HOUR SETUP						
2AC0	Initial Generator Running Hours	0 to 999999	1	h	F12	0
2AC2	Generator Running Hour Alarm	0 to 2	1	–	F115	0
2AC3	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2AC4	Generator Running Hour Limit	1 to 1000000	1	h	F12	1000
2AC6	Reserved					
ANALOG INPUT/OUTPUT / ANALOG OUTPUT 1						
2B00	Analog Output 1	0 to 42	1	–	F127	0
ANALOG INPUT/OUTPUT / ANALOG OUTPUT 2						
2B01	Analog Output 2	0 to 42	1	–	F127	0
ANALOG INPUT/OUTPUT / ANALOG OUTPUT 3						
2B02	Analog Output 3	0 to 42	1	–	F127	0
ANALOG INPUT/OUTPUT / ANALOG OUTPUT 4						
2B03	Analog Output 4	0 to 42	1	–	F127	0
ANALOG INPUT/OUTPUT / ANALOG OUTPUTS						
2B04	Ia Output Current Minimum	0 to 2000	1	× FLA	F3	0
2B05	Ia Output Current Maximum	0 to 2000	1	× FLA	F3	125
2B06	Ib Output Current Minimum	0 to 2000	1	× FLA	F3	0
2B07	Ib Output Current Maximum	0 to 2000	1	× FLA	F3	125
2B08	Ic Output Current Minimum	0 to 2000	1	× FLA	F3	0
2B09	Ic Output Current Maximum	0 to 2000	1	× FLA	F3	125
2B0A	Average Output Current Minimum	0 to 2000	1	× FLA	F3	0
2B0B	Average Output Current Maximum	0 to 2000	1	× FLA	F3	125
2B0C	Negative Sequence Current Minimum	0 to 2000	1	%FLA	F1	0
2B0D	Negative Sequence Current Maximum	0 to 2000	1	%FLA	F1	100
2B0E	Averaged Generator Load Minimum	0 to 2000	1	× FLA	F3	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 25 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
2B0F	Averaged Generator Load Maximum	0 to 2000	1	× FLA	F3	125
2B10	Hottest Stator RTD Minimum	–50 to 250	1	°C	F4	0
2B11	Hottest Stator RTD Maximum	–50 to 250	1	°C	F4	200
2B12	Hottest Bearing RTD Minimum	–50 to 250	1	°C	F4	0
2B13	Hottest Bearing RTD Maximum	–50 to 250	1	°C	F4	200
2B14	Ambient RTD Minimum	–50 to 250	1	°C	F4	0
2B15	Ambient RTD Maximum	–50 to 250	1	°C	F4	70
2B16	RTD #1 Minimum	–50 to 250	1	°C	F4	0
2B17	RTD #1 Maximum	–50 to 250	1	°C	F4	200
2B18	RTD #2 Minimum	–50 to 250	1	°C	F4	0
2B19	RTD #2 Maximum	–50 to 250	1	°C	F4	200
2B1A	RTD #3 Minimum	–50 to 250	1	°C	F4	0
2B1B	RTD #3 Maximum	–50 to 250	1	°C	F4	200
2B1C	RTD #4 Minimum	–50 to 250	1	°C	F4	0
2B1D	RTD #4 Maximum	–50 to 250	1	°C	F4	200
2B1E	RTD #5 Minimum	–50 to 250	1	°C	F4	0
2B1F	RTD #5 Maximum	–50 to 250	1	°C	F4	200
2B20	RTD #6 Minimum	–50 to 250	1	°C	F4	0
2B21	RTD #6 Maximum	–50 to 250	1	°C	F4	200
2B22	RTD #7 Minimum	–50 to 250	1	°C	F4	0
2B23	RTD #7 Maximum	–50 to 250	1	°C	F4	200
2B24	RTD #8 Minimum	–50 to 250	1	°C	F4	0
2B25	RTD #8 Maximum	–50 to 250	1	°C	F4	200
2B26	RTD #9 Minimum	–50 to 250	1	°C	F4	0
2B27	RTD #9 Maximum	–50 to 250	1	°C	F4	200
2B28	RTD #10 Minimum	–50 to 250	1	°C	F4	0
2B29	RTD #10 Maximum	–50 to 250	1	°C	F4	200
2B2A	RTD #11 Minimum	–50 to 250	1	°C	F4	0
2B2B	RTD #11 Maximum	–50 to 250	1	°C	F4	200
2B2C	RTD #12 Minimum	–50 to 250	1	°C	F4	0
2B2D	RTD #12 Maximum	–50 to 250	1	°C	F4	200
2B2E	AB Voltage Minimum	0 to 150	1	× Rated	F3	0
2B2F	AB Voltage Maximum	0 to 150	1	× Rated	F3	125
2B30	BC Voltage Minimum	0 to 150	1	× Rated	F3	0
2B31	BC Voltage Maximum	0 to 150	1	× Rated	F3	125
2B32	CA Voltage Minimum	0 to 150	1	× Rated	F3	0
2B33	CA Voltage Maximum	0 to 150	1	× Rated	F3	125
2B34	Average Voltage Minimum	0 to 150	1	× Rated	F3	0
2B35	Average Voltage Maximum	0 to 150	1	× Rated	F3	125
2B36	Volts/Hertz Minimum	0 to 200	1	× Rated	F3	0
2B37	Volts/Hertz Maximum	0 to 200	1	× Rated	F3	150
2B38	Frequency Minimum	0 to 9000	1	Hz	F3	5900
2B39	Frequency Maximum	0 to 9000	1	Hz	F3	6100
2B3C	Power Factor Minimum	–99 to 100	1	–	F6	80
2B3D	Power Factor Maximum	–99 to 100	1	–	F6	–80
2B3E	Reactive Power Minimum	–200 to 200	1	× Rated	F6	0
2B3F	Reactive Power Maximum	–200 to 200	1	× Rated	F6	125
2B40	Real Power (MW) Minimum	–200 to 200	1	× Rated	F6	0
2B41	Real Power (MW) Maximum	–200 to 200	1	× Rated	F6	125
2B42	Apparent Power Minimum	0 to 200	1	× Rated	F3	0
2B43	Apparent Power Maximum	0 to 200	1	× Rated	F3	125
2B44	Analog Input 1 Minimum	–50000 to 50000	1	Units	F12	0
2B46	Analog Input 1 Maximum	–50000 to 50000	1	Units	F12	50000

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 26 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
2B48	Analog Input 2 Minimum	–50000 to 50000	1	Units	F12	0
2B4A	Analog Input 2 Maximum	–50000 to 50000	1	Units	F12	50000
2B4C	Analog Input 3 Minimum	–50000 to 50000	1	Units	F12	0
2B4E	Analog Input 3 Maximum	–50000 to 50000	1	Units	F12	50000
2B50	Analog Input 4 Minimum	–50000 to 50000	1	Units	F12	0
2B52	Analog Input 4 Maximum	–50000 to 50000	1	Units	F12	50000
2B54	Tachometer Minimum	0 to 7200	1	RPM	F1	3500
2B55	Tachometer Maximum	0 to 7200	1	RPM	F1	3700
2B56	Thermal Capacity Used Minimum	0 to 100	1	%	F1	0
2B57	Thermal Capacity Used Maximum	0 to 100	1	%	F1	100
2B58	Neutral Voltage Third Harmonic Minimum	0 to 250000	1	Volts	F10	0
2B5A	Neutral Voltage Third Harmonic Maximum	0 to 250000	1	Volts	F10	450
2B5C	Current Demand Minimum	0 to 2000	1	× FLA	F3	0
2B5D	Current Demand Maximum	0 to 2000	1	× FLA	F3	125
2B5E	Mvar Demand Minimum	0 to 200	1	× Rated	F3	0
2B5F	Mvar Demand Maximum	0 to 200	1	× Rated	F3	125
2B60	MW Demand Minimum	0 to 200	1	× Rated	F3	0
2B61	MW Demand Maximum	0 to 200	1	× Rated	F3	125
2B62	MVA Demand Minimum	0 to 200	1	× Rated	F3	0
2B63	MVA Demand Maximum	0 to 200	1	× Rated	F3	125
ANALOG INPUT/OUTPUT / ANALOG INPUT 1						
2C00	Analog Input 1	0 to 3	1	–	F129	0
2C05	Analog Input 1 Units	0 to 6	1	–	F22	_
2C08	Analog Input 1 Minimum	–50000 to 50000	1	Units	F12	0
2C0A	Analog Input 1 Maximum	–50000 to 50000	1	Units	F12	100
2C0C	Block Analog Input 1 From Online	0 to 5000	1	s	F1	0
2C0D	Analog Input 1 Alarm	0 to 2	1	–	F115	0
2C0E	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2C0F	Analog Input 1 Alarm Level	–50000 to 50000	1	Units	F12	10
2C11	Analog Input 1 Alarm Pickup	0 to 1	1	–	F130	0
2C12	Analog Input 1 Alarm Delay	1 to 3000	1	s	F2	1
2C13	Analog Input 1 Alarm Events	0 to 1	1	–	F105	0
2C14	Analog Input 1 Trip	0 to 2	1	–	F115	0
2C15	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2C16	Analog Input 1 Trip Level	–50000 to 50000	1	Units	F12	20
2C18	Analog Input 1 Trip Pickup	0 to 1	1	–	F130	0
2C19	Analog Input 1 Trip Delay	1 to 3000	1	s	F2	1
2C1A	Analog Input 1 Name	0 to 12	1	–	F22	_
ANALOG INPUT/OUTPUT / ANALOG INPUT 2						
2C40	Analog Input 2	0 to 3	1	–	F129	0
2C45	Analog Input 2 Units	0 to 6	1	–	F22	_
2C48	Analog Input 2 Minimum	–50000 to 50000	1	Units	F12	0
2C4A	Analog Input 2 Maximum	–50000 to 50000	1	Units	F12	100
2C4C	Block Analog Input 2 From Online	0 to 5000	1	s	F1	0
2C4D	Analog Input 2 Alarm	0 to 2	1	–	F115	0
2C4E	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2C4F	Analog Input 2 Alarm Level	–50000 to 50000	1	Units	F12	10
2C51	Analog Input 2 Alarm Pickup	0 to 1	1	–	F130	0
2C52	Analog Input 2 Alarm Delay	1 to 3000	1	s	F2	1
2C53	Analog Input 2 Alarm Events	0 to 1	1	–	F105	0
2C54	Analog Input 2 Trip	0 to 2	1	–	F115	0
2C55	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2C56	Analog Input 2 Trip Level	–50000 to 50000	1	Units	F12	20

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 27 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
2C58	Analog Input 2 Trip Pickup	0 to 1	1	–	F130	0
2C59	Analog Input 2 Trip Delay	1 to 3000	1	s	F2	1
2C5A	Analog Input 2 Name	0 to 12	1	–	F22	_
ANALOG INPUT/OUTPUT / ANALOG INPUT 3						
2C80	Analog Input 3	0 to 3	1	–	F129	0
2C85	Analog Input 3 Units	0 to 6	1	–	F22	_
2C88	Analog Input 3 Minimum	–50000 to 50000	1	Units	F12	0
2C8A	Analog Input 3 Maximum	–50000 to 50000	1	Units	F12	100
2C8C	Block Analog Input 3 From Online	0 to 5000	1	s	F1	0
2C8D	Analog Input 3 Alarm	0 to 2	1	–	F115	0
2C8E	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2C8F	Analog Input 3 Alarm Level	–50000 to 50000	1	Units	F12	10
2C91	Analog Input 3 Alarm Pickup	0 to 1	1	–	F130	0
2C92	Analog Input 3 Alarm Delay	1 to 3000	1	s	F2	1
2C93	Analog Input 3 Alarm Events	0 to 1	1	–	F105	0
2C94	Analog Input 3 Trip	0 to 2	1	–	F115	0
2C95	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2C96	Analog Input 3 Trip Level	–50000 to 50000	1	Units	F12	20
2C98	Analog Input 3 Trip Pickup	0 to 1	1	–	F130	0
2C99	Analog Input 3 Trip Delay	1 to 3000	1	s	F2	1
2C9A	Analog Input 3 Name	0 to 12	1	–	F22	_
ANALOG INPUT/OUTPUT / ANALOG INPUT 4						
2CC0	Analog Input 4	0 to 3	1	–	F129	0
2CC5	Analog Input 4 Units	0 to 6	1	–	F22	_
2CC8	Analog Input 4 Minimum	–50000 to 50000	1	Units	F12	0
2CCA	Analog Input 4 Maximum	–50000 to 50000	1	Units	F12	100
2CCC	Block Analog Input 4 From Online	0 to 5000	1	s	F1	0
2CCD	Analog Input 4 Alarm	0 to 2	1	–	F115	0
2CCE	Assign Alarm Relays (2-5)	1 to 4	1	–	F50	16
2CCF	Analog Input 4 Alarm Level	–50000 to 50000	1	Units	F12	10
2CD1	Analog Input 4 Alarm Pickup	0 to 1	1	–	F130	0
2CD2	Analog Input 4 Alarm Delay	1 to 3000	1	s	F2	1
2CD3	Analog Input 4 Alarm Events	0 to 1	1	–	F105	0
2CD4	Analog Input 4 Trip	0 to 2	1	–	F115	0
2CD5	Assign Trip Relays (1-4)	0 to 3	1	–	F50	1
2CD6	Analog Input 4 Trip Level	–50000 to 50000	1	Units	F12	20
2CD8	Analog Input 4 Trip Pickup	0 to 1	1	–	F130	0
2CD9	Analog Input 4 Trip Delay	1 to 3000	1	s	F2	1
2CDA	Analog Input 4 Name	0 to 12	1	–	F22	_
489 TESTING / SIMULATION MODE						
2D00	Simulation Mode	0 to 3	1	–	F138	0
2D01	Pre-fault To Fault Time Delay	0 to 300	1	s	F1	15
489 TESTING / PRE-FAULT SETUP						
2D20	Pre-Fault Iphase Output	0 to 2000	1	× CT	F3	0
2D21	Pre-Fault Voltages Phase-N	0 to 150	1	× Rated	F3	100
2D22	Pre-Fault Current Lags Voltage	0 to 359	1	°	F1	0
2D23	Pre-Fault Iphase Neutral	0 to 2000	1	× CT	F3	0
2D24	Pre-Fault Current Ground	0 to 2000	1	× CT	F3	0
2D25	Pre-Fault Voltage Neutral	0 to 1000	1	Volts	F2	0
2D26	Pre-Fault Stator RTD Temp	–50 to 250	1	°C	F4	40
2D27	Pre-Fault Bearing RTD Temp	–50 to 250	1	°C	F4	40
2D28	Pre-Fault Other RTD Temp	–50 to 250	1	°C	F4	40
2D29	Pre-Fault Ambient RTD Temp	–50 to 250	1	°C	F4	40

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 28 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
2D2A	Pre-Fault System Frequency	50 to 900	1	Hz	F2	600
2D2B	Pre-Fault Analog Input 1	0 to 100	1	%	F1	0
2D2C	Pre-Fault Analog Input 2	0 to 100	1	%	F1	0
2D2D	Pre-Fault Analog Input 3	0 to 100	1	%	F1	0
2D2E	Pre-Fault Analog Input 4	0 to 100	1	%	F1	0
2D4C	Pre-Fault Stator RTD Temp	–50 to 250	1	°F	F4	40
2D4D	Pre-Fault Bearing RTD Temp	–50 to 250	1	°F	F4	40
2D4E	Pre-Fault Other RTD Temp	–50 to 250	1	°F	F4	40
2D4F	Pre-Fault Ambient RTD Temp	–50 to 250	1	°F	F4	40
489 TESTING / FAULT SETUP						
2D80	Fault Iphase Output	0 to 2000	1	× CT	F3	0
2D81	Fault Voltages Phase-N	0 to 150	1	× Rated	F3	100
2D82	Fault Current Lags Voltage	0 to 359	1	°	F1	0
2D83	Fault Iphase Neutral	0 to 2000	1	× CT	F3	0
2D84	Fault Current Ground	0 to 2000	1	× CT	F3	0
2D85	Fault Voltage Neutral	0 to 1000	1	Volts	F2	0
2D86	Fault Stator RTD Temp	–50 to 250	1	°C	F4	40
2D87	Fault Bearing RTD Temp	–50 to 250	1	°C	F4	40
2D88	Fault Other RTD Temp	–50 to 250	1	°C	F4	40
2D89	Fault Ambient RTD Temp	–50 to 250	1	°C	F4	40
2D8A	Fault System Frequency	50 to 900	1	Hz	F2	600
2D8B	Fault Analog Input 1	0 to 100	1	%	F1	0
2D8C	Fault Analog Input 2	0 to 100	1	%	F1	0
2D8D	Fault Analog Input 3	0 to 100	1	%	F1	0
2D8E	Fault Analog Input 4	0 to 100	1	%	F1	0
2DBC	Fault Stator RTD Temp	–50 to 250	1	°F	F4	40
2DBD	Fault Bearing RTD Temp	–50 to 250	1	°F	F4	40
2DBE	Fault Other RTD Temp	–50 to 250	1	°F	F4	40
2DBF	Fault Ambient RTD Temp	–50 to 250	1	°F	F4	40
489 TESTING / TEST OUTPUT RELAYS						
2DE0	Force Operation Of Relays	0 to 8	1	–	F139	0
489 TESTING / TEST ANALOG OUTPUT						
2DF0	Force Analog Outputs Function	0 to 1	1	–	F126	0
2DF1	Analog Output 1 Forced Value	0 to 100	1	%	F1	0
2DF2	Analog Output 2 Forced Value	0 to 100	1	%	F1	0
2DF3	Analog Output 3 Forced Value	0 to 100	1	%	F1	0
2DF4	Analog Output 4 Forced Value	0 to 100	1	%	F1	0
EVENT RECORDER / GENERAL						
3000	Event Recorder Last Reset Date (2 Words)	N/A	N/A	N/A	F18	N/A
3002	Total Number Of Events Since Last Clear	0 to 65535	1	N/A	F1	N/A
3003	Event Record Selector	0 to 65535	1	–	F1	0
EVENT RECORDER / SELECTED EVENT						
3004	Cause Of Event	0 to 139	1	–	F134	0
3005	Time Of Event (2 Words)	N/A	N/A	N/A	F19	N/A
3007	Date Of Event (2 Words)	N/A	N/A	N/A	F18	N/A
3009	Tachometer	0 to 7200	1	RPM	F1	0
300A	Phase A Current	0 to 999999	1	Amps	F12	0
300C	Phase B Current	0 to 999999	1	Amps	F12	0
300E	Phase C Current	0 to 999999	1	Amps	F12	0
3010	Phase A Differential Current	0 to 999999	1	Amps	F12	0
3012	Phase B Differential Current	0 to 999999	1	Amps	F12	0
3014	Phase C Differential Current	0 to 999999	1	Amps	F12	0
3016	Neg. Seq. Current	0 to 2000	1	%FLA	F1	0

1, 2, 3 See Table footnotes on page 39

Table 1: 489 Memory Map (Sheet 29 of 29)

ADDR	NAME	RANGE	STEP	UNITS	FORMAT	DEFAULT
3017	Ground Current	0 to 20000000	1	A	F14	0
3019	A-B Voltage	0 to 50000	1	Volts	F1	0
301A	B-C Voltage	0 to 50000	1	Volts	F1	0
301B	C-A Voltage	0 to 50000	1	Volts	F1	0
301C	Frequency	0 to 12000	1	Hz	F3	0
301D	Active Group	0 to 1	1	–	F1	0
301F	Real Power (MW)	–2000000 to 2000000	1	MW	F13	0
3021	Reactive Power Mvar	–2000000 to 2000000	1	Mar	F13	0
3023	Apparent Power MVA	0 to 2000000	1	MVA	F13	0
3025	Hottest Stator RTD Number	1 to 12	1	–	F1	1
3026	Hottest Stator RTD Temperature	–50 to 250	1	°C	F4	0
3027	Hottest Bearing RTD Number	1 to 12	1	–	F1	1
3028	Hottest Bearing RTD Temperature	–50 to 250	1	°C	F4	0
3029	Hottest Other RTD Number	1 to 12	1	–	F1	1
302A	Hottest Other RTD Temperature	–50 to 250	1	°C	F4	0
302B	Hottest Ambient RTD Number	1 to 12	1	–	F1	1
302C	Hottest Ambient RTD Temperature	–50 to 250	1	°C	F4	0
302D	Analog Input 1	–50000 to 50000	1	Units	F12	0
302F	Analog Input 2	–50000 to 50000	1	Units	F12	0
3031	Analog Input 3	–50000 to 50000	1	Units	F12	0
3033	Analog Input 4	–50000 to 50000	1	Units	F12	0
3035	Phase A Neutral Current	0 to 999999	1	Amps	F12	0
3037	Phase B Neutral Current	0 to 999999	1	Amps	F12	0
3039	Phase C Neutral Current	0 to 999999	1	Amps	F12	0
30E0	Hottest Stator RTD Temperature	–50 to 250	1	°F	F4	0
30E1	Hottest Bearing RTD Temperature	–50 to 250	1	°F	F4	0
30E2	Hottest Other RTD Temperature	–50 to 250	1	°F	F4	0
30E3	Hottest Ambient RTD Temperature	–50 to 250	1	°F	F4	0
30E5	Neutral Voltage (Fundamental)	0 to 250000	1	Volts	F10	0
30E7	Neutral Voltage (3rd Harmonic)	0 to 250000	1	Volts	F10	0
30E9	Vab/Iab	0 to 65535	1	ohms s	F1	0
30EA	Vab/Iab Angle	0 to 359	1	°	F1	0
WAVEFORM MEMORY SETUP						
30F0	Waveform Memory Trigger Date	N/A	N/A	N/A	F18	N/A
30F2	Waveform Memory Trigger Time	N/A	N/A	N/A	F19	N/A
30F4	Frequency During Trace Acquisition	0 to 12000	1	Hz	F3	0
30F5	Waveform Memory Channel Selector (Holding Register)	0 to 9	1	N/A	F214	0
30F6	Waveform Trigger Selector	1 to 65535	1	N/A	F1	0
30F7	Waveform Trigger Cause (Read-only)	0 to 139	1	N/A	F134	0
30F8	Number of Samples per Waveform Capture	1 to 768	1	N/A	F1	168
30F9	Number of Waveform Captures Taken	0 to 65535	1	N/A	F1	0
WAVEFORM MEMORY SAMPLES						
3100	First Waveform Memory Sample	–32767 to 32767	1	N/A	F4	0
3400	Last Waveform Memory Sample	–32767 to 32767	1	N/A	F4	0

1, 2, 3 See Table footnotes on page 39

1. A Value of 65535 indicates 'Never'
2. A value of 0xFFFF indicates "no measurable value".
3. Maximum value turns feature 'Off'

Memory Map Data Formats

The data formats used in the Modbus memory map are shown below.

Table 2: Data Formats (Sheet 1 of 12)

CODE	TYPE	DEFINITION
F1	**16 bits**	**UNSIGNED VALUE**
	Example: 1234 stored as 1234	
F2	**16 bits**	**UNSIGNED VALUE, 1 DECIMAL PLACE**
	Example: 123.4 stored as 1234	
F3	**16 bits**	**UNSIGNED VALUE, 2 DECIMAL PLACES**
	Example: 12.34 stored as 1234	
F4	**16 bits**	**2's COMPLEMENT SIGNED VALUE**
	Example: –1234 stored as –1234 (i.e. 64302)	
F5	**16 bits**	**2's COMPLEMENT SIGNED VALUE 1 DECIMAL PLACES**
	Example: -123.4 stored as -1234 (i.e. 64302)	
F6	**16 bits**	**2's COMPLEMENT SIGNED VALUE 2 DECIMAL PLACES**
	Example: –12.34 stored as –1234 (i.e. 64302)	
F10	**32 bits**	**2's COMPLEMENT SIGNED LONG VALUE 1 DECIMAL PLACE**
	1st 16 bits	High Order Word of Long Value
	2nd 16 bits	Low Order Word of Long Value
	Example: –12345.6 stored as –123456 (i.e. 1st word: FFFE hex, 2nd word: 1DC0 hex)	
F12	**32 bits**	**2's COMPLEMENT SIGNED LONG VALUE**
	1st 16 bits	High Order Word of Long Value
	2nd 16 bits	Low Order Word of Long Value
	Example: -123456 stored as -123456 (i.e. 1st word: FFFE hex, 2nd word: 1DC0 hex)	
F13	**32 bits**	**2's COMPLEMENT SIGNED LONG VALUE, 3 DECIMAL PLACES**
	1st 16 bits	High Order Word of Long Value
	2nd 16 bits	Low Order Word of Long Value
	Example: -123.456 stored as -123456 (i.e. 1st word: FFFE hex, 2nd word: 1DC0 hex)	
F14	**32 bits**	**2's COMPLEMENT SIGNED LONG VALUE, 2 DECIMAL PLACES**
	1st 16 bits	High Order Word of Long Value
	2nd 16 bits	Low Order Word of Long Value
	Example: -1234.56 stored as -123456 (i.e. 1st word: FFFE hex, 2nd word: 1DC0 hex)	

Table 2: Data Formats (Sheet 2 of 12)

CODE	TYPE	DEFINITION
F15	**16 bits**	**HARDWARE REVISION**
	0000 0000 0000 0001	1 = A
	0000 0000 0000 0010	2 = B
	...	...
	0000 0000 0001 1010	26 = Z
F16	**16 bits**	**SOFTWARE REVISION**
	1111 1111 xxxx xxxx	Major Revision Number 0 to 9 in steps of 1
	xxxx xxxx 1111 1111	Minor Revision Number (two BCD digits) 00 to 99 in steps of 1
	Example: Revision 2.30 stored as 0230 hex	
F18	**32 bits**	**DATE (MM/DD/YYYY)**
	1st byte	Month (1 to 12)
	2nd byte	Day (1 to 31)
	3rd & 4th byte	Year (1995 to 2094)
	Example: Feb. 20, 1996 stored as 34867148 (i.e. 1st word: 0214, 2nd word 07CC)	
F19	**32 bits**	**TIME (HH:MM:SS:hh)**
	1st byte	Hours (0 to 23)
	2nd byte	Minutes (0 to 59)
	3rd byte	Seconds (0 to 59)
	4th byte	Hundreds of seconds (0 to 99)
	Example: 2:05pm stored as 235208704 (i.e. 1st word: 0E05, 2nd word 0000)	
F20	**32 bits**	**2's COMPLEMENT SIGNED LONG VALUE**
	1st 16 bits	High Order Word of Long Value
	2nd 16 bits	Low Order Word of Long Value
	Note: -1 means "Never"	
F22	**16 bits**	**TWO 8-BIT CHARACTERS PACKED INTO 16-BIT UNSIGNED**
	MSB	First Character
	LSB	Second Character
	Example: String 'AB' stored as 4142 hex.	
F24	**32 bits**	**TIME FORMAT FOR BROADCAST**
	1st byte	Hours (0 to 23)
	2nd byte	Minutes (0 to 59)
	3rd & 4th bytes	Milliseconds (0 to 59999) Note: Clock resolution limited to 0.01 sec
	Example: 1:15:48:572 stored as 17808828 (i.e., 1st word 010F, 2nd word BDBC)	

Table 2: Data Formats (Sheet 3 of 12)

CODE	TYPE	DEFINITION
F100	**Unsigned 16 bit integer**	**TEMPEATURE DISPLAY UNITS**
	0	Celsius
	1	Fahrenheit
FC101	**Unsigned 16 bit integer**	**RS 485 BAUD RATE**
	0	300 baud
	1	1200 baud
	2	2400 baud
	3	4800 baud
	4	9600 baud
	5	19200 baud
F102	**Unsigned 16 bit integer**	**RS 485 PARITY**
	0	None
	1	Odd
	2	Even
F103	**Unsigned 16 bit integer**	**NO/YES SELECTION**
	0	No
	1	Yes
F104	**Unsigned 16 bit integer**	**GROUND CT TYPE**
	0	None
	1	1 A Secondary
	2	50/0.025 Ground CT
	3	5 A Secondary
F105	**Unsigned 16 bit integer**	**OFF/ON SELECTION**
	0	Off
	1	On
F106	**Unsigned 16 bit integer**	**VOLTAGE TRANSFORMER CONNECTION TYPE**
	0	None
	1	Open Delta
	2	Wye
F107	**Unsigned 16 bit integer**	**NOMINAL FREQUENCY**
	0	----
	1	60 Hz
	2	50 Hz
	3	25 Hz
F109	**Unsigned 16 bit integer**	**STARTER STATUS SWITCH**
	0	Auxiliary A
	1	Auxiliary B
F115	**Unsigned 16 bit integer**	**ALARM / TRIP TYPE SELECTION**
	0	Off
	1	Latched
	2	Unlatched

Table 2: Data Formats (Sheet 4 of 12)

CODE	TYPE	DEFINITION
F117	**Unsigned 16 bit integer**	**RESET MODE**
	0	All Resets
	1	Remote Reset Only
	2	Keypad Reset Only
F118	**Unsigned 16 bit integer**	**SETPOINT GROUP**
	0	Group 1
	1	Group 2
F120	**Unsigned 16 bit integer**	**RTD TYPE**
	0	100 Ohm Platinum
	1	120 Ohm Nickel
	2	100 Ohm Nickel
	3	10 Ohm Copper
F121	**Unsigned 16 bit integer**	**RTD APPLICATION**
	0	None
	1	Stator
	2	Bearing
	3	Ambient
	4	Other
F122	**Unsigned 16 bit integer**	**RTD VOTING SELECTION**
	1	RTD #1
	2	RTD #2
	3	RTD #3
	4	RTD #4
	5	RTD #5
	6	RTD #6
	7	RTD #7
	8	RTD #8
	9	RTD #9
	10	RTD #10
	11	RTD #11
	12	RTD #12
F123	**Unsigned 16 bit integer**	**ALARM/TRIP STATUS**
	0	Not Enabled
	1	Inactive
	2	Timing Out
	3	Active Trip
	4	Latched Trip
F124	**Unsigned 16 bit integer**	**PHASE ROTATION SELECTION**
	0	----
	1	ABC
	2	ACB
F126	**Unsigned 16 bit**	**DISABLED / ENABLED SELECTION**
	0	Disabled
	1	Enabled

Table 2: Data Formats (Sheet 5 of 12)

CODE	TYPE	DEFINITION
F127	**Unsigned 16 bit integer**	**ANALOG OUTPUT PARAMETER SELECTION**
	0	None
	1	IA Output Current
	2	IB Output Current
	3	IC Output Current
	4	Average Output Current
	5	Negative Sequence Current
	6	Average Generator Load
	7	Hottest Stator RTD
	8	Hottest Bearing RTD
	9	Ambient RTD
	10	RTD #1
	11	RTD #2
	12	RTD #3
	13	RTD #4
	14	RTD #5
	15	RTD #6
	16	RTD #7
	17	RTD #8
	18	RTD #9
	19	RTD #10
	20	RTD #11
	21	RTD #12
	22	AB Voltage
	23	BC Voltage
	24	CA Voltage
	25	Average Voltage
	26	Volts/Hertz
	27	Frequency
	28	Third Harmonic Neutral Voltage
	29	Power Factor
	30	Reactive Power (Mvar)
	31	Real Power (MW)
	32	Apparent Power (MVA)
	33	Analog Input 1
	34	Analog Input 2
	35	Analog Input 3
	36	Analog Input 4
	37	Tachometer
	38	Thermal Capacity Used
	39	Current Demand
	40	Mvar Demand
	41	MW Demand
	42	MVA Demand
F128	**Unsigned 16 bit integer**	**OVERCURRENT CURVE STYLE SELECTION**
	0	ANSI Extremely Inverse
	1	ANSI Very Inverse
	2	ANSI Normally Inverse
	3	ANSI Moderately Inverse
	4	IEC Curve A (BS142)

Table 2: Data Formats (Sheet 6 of 12)

CODE	TYPE	DEFINITION
F128 ctd.	5	IEC Curve B (BS142)
	6	IEC Curve C (BS142)
	7	IEC Short Inverse
	8	IAC Extremely Inverse
	9	IAC Very Inverse
	10	IAC Inverse
	11	IAC Short Inverse
	12	FlexCurve™
	13	Definite Time
FC129	**Unsigned 16 bit integer**	**ANALOG INPUT SELECTION**
	0	Disabled
	1	4 to 20 mA
	2	0 to 20 mA
	3	0 to 1 mA
F130	**Unsigned 16 bit integer**	**PICKUP TYPE**
	0	Over
	1	Under
FC131	**Unsigned 16 bit integer**	**INPUT SWITCH STATUS**
	0	Closed
	1	Open
F132	**Unsigned 16 bit integer**	**TRIP COIL SUPERVISION STATUS**
	0	No Coil
	1	Coil
F133	**Unsigned 16 bit integer**	**GENERATOR STATUS**
	0	Offline
	1	Offline
	2	Online
	3	Overload
	4	Tripped
F134	**Unsigned 16 bit integer**	**CAUSE OF EVENT / CAUSE OF LAST TRIP**
	0	No Event
	1	General Switch A Trip
	2	General Switch B Trip
	3	General Switch C Trip
	4	General Switch D Trip
	5	General Switch E Trip
	6	General Switch F Trip
	7	General Switch G Trip
	8	Sequential Trip
	9	Tachometer Trip
	10	Unknown Trip
	11	Unknown Trip
	12	Overload Trip
	13	Unknown Trip
	14	Neutral Overvoltage Trip
	15	Neutral Undervoltage (3rd Harmonic) Trip

Table 2: Data Formats (Sheet 7 of 12)

CODE	TYPE	DEFINITION
F134 ctd.	16	Not Used
	17	Not Used
	18	Not Used
	19	Not Used
	20	Differential Trip
	21	Acceleration Trip
	22	RTD 1 Trip
	23	RTD 2 Trip
	24	RTD 3 Trip
	25	RTD 4 Trip
	26	RTD 5 Trip
	27	RTD 6 Trip
	28	RTD 7 Trip
	29	RTD 8 Trip
	30	RTD 9 Trip
	31	RTD 10 Trip
	32	RTD 11 Trip
	33	RTD 12 Trip
	34	Undervoltage Trip
	35	Overvoltage Trip
	36	Phase Reversal Trip
	37	Overfrequency Trip
	38	Power Factor Trip
	39	Reactive Power Trip
	40	Underfrequency Trip
	41	Analog Input 1 Trip
	42	Analog Input 2 Trip
	43	Analog Input 3 Trip
	44	Analog Input 4 Trip
	45	Single Phasing Trip
	46	Reverse Power Trip
	47	Field-Breaker Discrepancy
	48	Offline Overcurrent Trip
	49	Phase Overcurrent Trip
	50	Negative Sequence Overcurrent Trip
	51	General Switch A Alarm
	52	General Switch B Alarm
	53	General Switch C Alarm
	54	General Switch D Alarm
	55	General Switch E Alarm
	56	General Switch F Alarm
	57	General Switch G Alarm
	58	Not Used
	59	Tachometer Alarm
	60	Thermal Model Alarm
	61	Overload Alarm
	62	Underfrequency Alarm
	63	Not Used
	64	Ground Fault Alarm
	65	RTD 1 Alarm
	66	RTD 2 Alarm
	67	RTD 3 Alarm
	68	RTD 4 Alarm

Table 2: Data Formats (Sheet 8 of 12)

CODE	TYPE	DEFINITION
F134 ctd.	69	RTD 5 Alarm
	70	RTD 6 Alarm
	71	RTD 7 Alarm
	72	RTD 8 Alarm
	73	RTD 9 Alarm
	74	RTD 10 Alarm
	75	RTD 11 Alarm
	76	RTD 12 Alarm
	77	Open RTD Alarm
	78	Short/Low RTD Alarm
	79	Undervoltage Alarm
	80	Overvoltage Alarm
	81	Overfrequency Alarm
	82	Power Factor Alarm
	83	Reactive Power Alarm
	84	Low Forward Power Alarm
	85	Trip Counter Alarm
	86	Breaker Failure Alarm
	87	Current Demand Alarm
	88	kW Demand Alarm
	89	kvar Demand Alarm
	90	kVA Demand Alarm
	91	Broken Rotor Bar
	92	Analog Input 1 Alarm
	93	Analog Input 2 Alarm
	94	Analog Input 3 Alarm
	95	Analog Input 4 Alarm
	96	Reverse Power Alarm
	97	Incomplete Sequence Alarm
	98	Negative Sequence Alarm
	99	Ground Overcurrent Alarm
	100	Not Used
	101	Service Alarm
	102	Control Power Lost
	103	Control Power Applied
	104	Thermal Reset Close
	105	Emergency Reset Open
	106	Start While Blocked
	107	Relay Not Inserted
	108	Trip Coil Supervision
	109	Breaker Failure
	110	VT Fuse Failure
	111	Simulation Started
	112	Simulation Stopped
	113	Ground Overcurrent Trip
	114	Volts/Hertz Trip
	115	Volts/Hertz Alarm
	116	Low Forward Power Trip
	117	Inadvertent Energization
	118	Serial Start Command
	119	Serial Stop Command
	120	Input A Control
	121	Input B Control

Table 2: Data Formats (Sheet 9 of 12)

CODE	TYPE	DEFINITION
F134 ctd.	122	Input C Control
	123	Input D Control
	124	Input E Control
	125	Input F Control
	126	Input G Control
	127	Neutral Overvoltage Alarm
	128	Neutral Undervoltage (3rd Harmonic) Alarm
	129	Setpoint Group 1 Active
	130	Setpoint Group 2 Active
	131	Loss of Excitation 1
	132	Loss of Excitation 2
	133	Ground Directional Trip
	134	Ground Directional Alarm
	135	High-Set Phase Overcurrent Trip
	136	Distance Zone 1 Trip
	137	Distance Zone 2 Trip
	138	Digital Input Waveform Trigger
	139	Serial Waveform Trigger
F136	**Unsigned 16 bit integer**	**ORDER CODE**
	Bit 0	0 = P5 (5 A CT secondary), 1 = P1 (1 A CT secondary)
	Bit 1	0 = HI (High Voltage Power Supply), 1 = LO (Low Voltage Power Supply)
	Bit 2	0 = A20 (4 to 20 mA Analog Outputs), 1 = A1 (0 to 1 mA Analog Outputs)
F138	**Unsigned 16 bit integer**	**SIMULATION MODE**
	0	Off
	1	Simulate Pre-Fault
	2	Simulate Fault
	3	Pre-Fault to Fault
F139	**Unsigned 16 bit integer**	**FORCE OPERATION OF RELAYS**
	0	Disabled
	1	1 TRIP
	2	2 AUXILIARY
	3	3 AUXILIARY
	4	4 AUXILIARY
	5	5 ALARM
	6	6 SERVICE
	7	All Relays
	8	No Relays
F140	**16 bits**	**GENERAL STATUS**
	bit 0	Relay in Service
	bit 1	Active Trip Condition
	bit 2	Active Alarm Condition
	bit 3	Reserved

Table 2: Data Formats (Sheet 10 of 12)

CODE	TYPE	DEFINITION
F140 ctd.	bit 4	Reserved
	bit 5	Reserved
	bit 6	Reserved
	bit 7	Simulation Mode Enabled
	bit 8	Breaker Open LED
	bit 9	Breaker Closed LED
	bit 10	Hot Stator LED
	bit 11	Negative Sequence LED
	bit 12	Ground LED
	bit 13	Loss of Field LED
	bit 14	VT Failure LED
	bit 15	Breaker Failure LED
F141	**16 bits**	**OUTPUT RELAY STATUS**
	bit 0	1 TRIP
	bit 1	2 AUXILIARY
	bit 2	3 AUXILIARY
	bit 3	4 AUXILIARY
	bit 4	5 ALARM
	bit 5	6 SERVICE
	bit 6 to bit 15	Not Used
F142	**Unsigned 16 bit integer**	**THERMAL MODEL CURVE STYLE SELECTION**
	0	Standard
	1	Custom
	2	Voltage Dependent
F200	**Unsigned 16 bit integer**	**COMMUNICATION MONITOR BUFFER STATUS**
	0	Buffer Cleared
	1	Received OK
	2	Wrong Slave Address
	3	Illegal Function
	4	Illegal Count
	5	Illegal Register Address
	6	CRC Error
	7	Illegal Data
F201	**Unsigned 16 bit integer**	**CURVE RESET TYPE**
	0	Instantaneous
	1	Linear
F202	**Unsigned 16 bit integer**	**INADVERTENT ENERGIZATION ARMING TYPE**
	0	Undervoltage and Offline
	1	Undervoltage or Offline
F206	**Unsigned 16 bit integer**	**SEQUENTIAL TRIP TYPE**
	0	Low Forward Power
	1	Reverse Power
F207	**Unsigned 16 bit integer**	**SWITCH STATUS**
	0	Open
	1	Shorted

Table 2: Data Formats (Sheet 11 of 12)

CODE	TYPE	DEFINITION
F208	**Unsigned 16 bit integer**	**UNDERVOLTAGE TRIP ELEMENT TYPE**
	0	Curve
	1	Definite Time
F209	**Unsigned 16 bit integer**	**BREAKER OPERATION TYPE**
	0	Breaker Auxiliary A
	1	Breaker Auxiliary B
F210	**Unsigned 16 bit integer**	**ASSIGNABLE INPUT SELECTION**
	0	None
	1	Input 1
	2	Input 2
	3	Input 3
	4	Input 4
	5	Input 5
	6	Input 6
	7	Input 7
F211	**Unsigned 16 bit integer**	**VOLTS/HERTZ ELEMENT TYPE**
	0	Curve #1
	1	Curve #2
	2	Curve #3
	3	Definite Time
F212	**Unsigned 16 bit integer**	**RTD NUMBER**
	0	All
	1	RTD #1
	2	RTD #2
	3	RTD #3
	4	RTD #4
	5	RTD #5
	6	RTD #6
	7	RTD #7
	8	RTD #8
	9	RTD #9
	10	RTD #10
	11	RTD #11
	12	RTD #12
F213	**Unsigned 16 bit integer**	**COMMUNICATIONS MONITOR PORT SELECTION**
	0	Computer RS485
	1	Auxiliary RS485
	2	Front Panel RS232

Table 2: Data Formats (Sheet 12 of 12)

CODE	TYPE	DEFINITION
F214	**Unsigned 16 bit integer**	**WAVEFORM MEMORY CHANNEL SELECTOR**
	0	Phase A Line Current 512 counts = 1 × CT
	1	Phase B Line Current 512 counts = 1 × CT
	2	Phase C Line Current 512 counts = 1 × CT
	3	Phase A Line Current 512 counts = 1 × CT
	4	Neutral-End Phase A Line Current 512 counts = 1 × CT
	5	Neutral-End Phase B Line Current 512 counts = 1 × CT
	6	Neutral-End Phase C Line Current 512 counts = 1 × CT
	7	Phase A to Neutral Voltage; 3500 counts = 120 secondary volts
	8	Phase B to Neutral Voltage; 3500 counts = 120 secondary volts
	9	Phase C to Neutral Voltage; 3500 counts = 120 secondary volts
F215	**Unsigned 16 bit integer**	**CURRENT SOURCE**
	0	Neutral-End CTs
	1	Output-End CTs
F216	**Unsigned 16 bit integer**	**DNP PORT SELECTION**
	0	None
	1	Computer RS485
	2	Auxiliary RS485
	3	Front Panel RS485
F217	**Unsigned 16 bit integer**	**GROUND DIRECTIONAL MTA**
	0	0 degrees
	1	90 degrees
	2	180 degrees
	3	270 degrees
F218	**Unsigned 16 bit integer**	**BREAKER STATE**
	0	52 Closed
	1	52 Open/Closed
F219	**Unsigned 16 bit integer**	**STEP-UP TRANSFORMER TYPE**
	0	None
	1	Delta/Wye
F220	**Unsigned 16 bit integer**	**IRIG-B TYPE**
	0	None
	1	DC Shift
	2	Amplitude Modulated

DNP Protocol

Device Profile Document

The communications port configured as a DNP slave port must support the full set of features listed in the Level 2 DNP V3.00 Implementation (DNP-L2) described in Chapter 2 of the subset definitions. See the DNP protocol website at http://www.dnp.org for details

DNP 3.0: DEVICE PROFILE DOCUMENT	
Vendor Name: General Electric Multilin Inc.	
Device Name: 489 Generator Management Relay	
Highest DNP Level Supported: For Requests: Level 2 For Responses: Level 2	Device Function: ❒ Master ☒ Slave
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): Binary Input (Object 1, variations 1 and 2) Binary Output (Object 10, variation 2) Binary Counter (Object 20, variations 5 and 6) Frozen Counter (Object 21, variations 9 and 10) Analog Input (Object 30, variations 1, 2, 3, and 4) Analog Input Change (Object 32, variations 1, 2, 3, and 4) Warm Restart (Function Code 14)	
Maximum Data Link Frame Size (octets): Transmitted: 292 Received: 292	Maximum Application Fragment Size (octets): Transmitted: 2048 Received: 2048
Maximum Data Link Re-tries: ☒ None ❒ Fixed ❒ Configurable	Maximum Application Layer Re-tries: ☒ None ❒ Configurable
Requires Data Link Layer Confirmation: ☒ Never ❒ Always ❒ Sometimes ❒ Configurable	
Requires Application Layer Confirmation: ❒ Never ❒ Always ☒ When reporting Event Data ❒ When sending multi-fragment responses ❒ Sometimes ❒ Configurable	
Timeouts while waiting for: Data Link Confirm ☒ None ❒ Fixed ❒ Variable ❒ Configurable Complete Appl. Fragment ☒ None ❒ Fixed ❒ Variable ❒ Configurable Application Confirm ☒ None ❒ Fixed ❒ Variable ❒ Configurable (fixed value is 5000 milliseconds) Complete Appl. Response ☒ None ❒ Fixed ❒ Variable ❒ Configurable Others: (None)	

DNP 3.0: DEVICE PROFILE DOCUMENT (Continued)				
Executes Control Operations:				
Write Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Select/Operate	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Direct Operate	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Direct Operate: No Ack	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Count > 1	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Pulse Off	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Latch On	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Latch Off	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
See *Binary / Control Relay Output Block (Objects 10/12)* on page 51 for an explanation of the above.				
Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Reports Binary Input Change Events when no specific variations requested: ☐ Never ☒ Only time-tagged ☐ Only non-time-tagged ☐ Configurable to send both, one or the other	Reports time-tagged Binary Input Change Events when no specific variation requested: ☐ Never ☒ Binary Input Change With Time ☐ Binary Input Change With Relative Time ☐ Configurable
Sends Unsolicited Responses: ☒ Never ☐ Configurable ☐ Only certain objects ☐ Sometimes ☐ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses: ☒ Never ☐ When Device Restarts ☐ When Status Flags Change
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable ☒ Default Object / Default Variation ☐ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable ☐ 16 Bits ☐ 32 Bits ☐ Other Value ☒ Point-by-point list attached
Sends Multi-Fragment Responses: ☐ Yes ☒ No	

Implementation Table

The table below gives a list of all objects recognized and returned by the relay. Additional information is provided on the following pages including a list of the default variations returned for each object and lists of defined point numbers for each object.

Implementation Table Notes:

1. For this object, the quantity specified in the request must be exactly 1 as there is only one instance of this object defined in the relay.
2. All static data known to the relay is returned in response to a request for Class 0. This includes all objects of type 1 (Binary Input), type 10 (Binary Output), type 20 (Binary Counter), type 21 (Frozen Counter) and type 30 (Analog Input).
3. The point tables for Binary Input and Analog Input objects contain a field that defines to which event class the corresponding static data point has been assigned.
4. For this object, the qualifier code must specify an index of 7 only.
5. Delay Measurement (function code 23) is supported since the relay allows for writing the time via object 50 and it also periodically sets the "Time Synchronization Required" Internal Indication (IIN). The IIN is set at power-up and will be set again 24 hours after it was last cleared. The IIN is cleared when time is written as object 50 data or if IRIG-B is enabled and relay time is updated as a result of a successful decoding of this signal.

Table 3: DNP Implementation Table

Object			Request		Response	
Obj	Var	Description	Func Codes	Qual Codes (Hex)	Func Codes	Qual Codes (Hex)
1	0	Binary Input - All Variations	1	06		
1	1	Binary Input	1	00, 01, 06	129	00, 01
1	2	Binary Input With Status (Note 6)	1	00, 01, 06	129	00, 01
2	0	Binary Input Change - All Variations	1	06, 07, 08		
2	1	Binary Input Change Without Time	1	06, 07, 08	129	17, 28
2	2	Binary Input Change With Time	1	06, 07, 08	129	17, 28
10	0	Binary Output - All Variations	1	06		
10	2	Binary Output Status	1	00, 01, 06	129	00, 01
12	1	Control Relay Output Block	3, 4, 5, 6	17, 28	129	17, 28
20	0	Binary Counter - All Variations	1, 7, 8, 9, 10	06	129	00, 01
20	5	32-Bit Binary Counter without Flag	1, 7, 8, 9, 10	06	129	00, 01
20	6	16-Bit Binary Counter without Flag	1, 7, 8, 9, 10	06	129	00, 01
21	0	Frozen Counter - All Variations	1	06	129	00, 01
21	9	32-Bit Frozen Counter without Flag	1	06	129	00, 01
21	10	16-Bit Frozen Counter without Flag	1	06	129	00, 01
30	0	Analog Input - All Variations	1	06		
30	1	32-Bit Analog Input With Flag	1	00, 01, 06	129	00, 01
30	2	16-Bit Analog Input With Flag	1	00, 01, 06	129	00, 01
30	3	32-Bit Analog Input Without Flag	1	00, 01, 06	129	00, 01
30	4	16-Bit Analog Input Without Flag	1	00, 01, 06	129	00, 01
32	0	Analog Input Change - All Variations	1	06, 07, 08		
32	1	32-Bit Analog Input Change without Time	1	06, 07, 08	129	17, 28
32	2	16-Bit Analog Input Change without Time	1	06, 07, 08	129	17, 28
32	3	32-Bit Analog Input Change with Time	1	06, 07, 08	129	17, 28
32	4	16-Bit Analog Input Change with Time	1	06, 07, 08	129	17, 28
50	1	Time and Date	1, 2	07 (Note 1)	129	07
60	1	Class 0 Data (Note 2)	1	06	129	
60	2	Class 1 Data (Note 3)	1	06, 07, 08	129	
60	3	Class 2 Data (Note 3)	1	06, 07, 08	129	
60	4	Class 3 Data (Note 3)	1	06, 07, 08	129	
80	1	Internal Indications	2	00 (Note 4)	129	
		No object - Cold Start	13			
		No object - Warm Start	14			
		No object - Delay Measurement (Note 5)	23			

Default Variations

The following table specifies the default variation for all objects returned by the relay. These are the variations that will be returned for the object in a response when no specific variation is specified in a request.

Table 4: Default Variations

OBJECT	DESCRIPTION	DEFAULT VARIATION
1	Binary Input - Single Bit	1
2	Binary Input Change With Time	2
10	Binary Output Status	2
20	16-Bit Binary Counter without Flag	6
21	16-Bit Frozen Counter without Flag	10
30	32-Bit Analog Input Without Flag	3
32	32-Bit Analog Input Change Without Time	1

DNP Point Lists

Binary Input / Binary Input Change (Objects 01/02)

The point list for Binary Inputs (Object 01) and Binary Input Change (Object 02) is shown below:

Table 5: Binary Inputs (Sheet 1 of 4)

Idx	Description	Class
0	Relay In Service	Class 1
1	Trip Condition Active	Class 1
2	Alarm Condition Active	Class 1
3	Simulation Mode Enabled	Class 1
4	Breaker Is Open	Class 1
5	Breaker Is Closed	Class 1
6	Hot Stator Fault Active	Class 1
7	Negative Sequence Fault Active	Class 1
8	Ground Fault Active	Class 1
9	Loss Of Field Fault Active	Class 1
10	VT Failure Detected	Class 1
11	Breaker Failure Detected	Class 1
12	Relay 1 Trip Operated	Class 1
13	Relay 2 Auxiliary Operated	Class 1
14	Relay 3 Auxiliary Operated	Class 1
15	Relay 4 Auxiliary Operated	Class 1
16	Relay 5 Alarm Operated	Class 1
17	Relay 6 Service Operated	Class 1
18	Setpoint Access Input Closed	Class 1
19	Breaker Status Input Closed	Class 1
20	Assignable Input 1 Closed	Class 1
21	Assignable Input 2 Closed	Class 1
22	Assignable Input 3 Closed	Class 1
23	Assignable Input 4 Closed	Class 1
24	Assignable Input 5 Closed	Class 1
25	Assignable Input 6 Closed	Class 1
26	Assignable Input 7 Closed	Class 1
27	Trip Coil Supervision - Coil Detected	Class 1
40	Assignable Input 1 Trip Active or Latched	Class 1
41	Assignable Input 2 Trip Active or Latched	Class 1
42	Assignable Input 3 Trip Active or Latched	Class 1
43	Assignable Input 4 Trip Active or Latched	Class 1
44	Assignable Input 5 Trip Active or Latched	Class 1
45	Assignable Input 6 Trip Active or Latched	Class 1
46	Assignable Input 7 Trip Active or Latched	Class 1
47	Sequential Trip Active or Latched	Class 1
48	Field-Breaker Discrepancy Trip Active or Latched	Class 1
49	Tachometer Trip Active or Latched	Class 1

Table 5: Binary Inputs (Sheet 2 of 4)

Idx	Description	Class
50	Offline Overcurrent Trip Active or Latched	Class 1
51	Inadvertent Energization Trip Active or Latched	Class 1
52	Phase Overcurrent Trip Active or Latched	Class 1
53	Negative Sequence Overcurrent Trip Active or Latched	Class 1
54	Ground Overcurrent Trip Active or Latched	Class 1
55	Phase Differential Trip Active or Latched	Class 1
56	Undervoltage Trip Active or Latched	Class 1
57	Overvoltage Trip Active or Latched	Class 1
58	Volts/Hertz Trip Active or Latched	Class 1
59	Phase Reversal Trip Active or Latched	Class 1
60	Underfrequency Trip Active or Latched	Class 1
61	Overfrequency Trip Active or Latched	Class 1
62	Neutral Overvoltage Trip Active or Latched	Class 1
63	Neutral Undervoltage (Third Harmonic) Trip Active or Latched	Class 1
64	Reactive Power Trip Active or Latched	Class 1
65	Reverse Power Trip Active or Latched	Class 1
66	Low Fwd Power Trip Active or Latched	Class 1
67	Thermal Model Trip Active or Latched	Class 1
68	RTD 1 Trip Active or Latched	Class 1
69	RTD 2 Trip Active or Latched	Class 1
70	RTD 3 Trip Active or Latched	Class 1
71	RTD 4 Trip Active or Latched	Class 1
72	RTD 5 Trip Active or Latched	Class 1
73	RTD 6 Trip Active or Latched	Class 1
74	RTD 7 Trip Active or Latched	Class 1
75	RTD 8 Trip Active or Latched	Class 1
76	RTD 9 Trip Active or Latched	Class 1
77	RTD 10 Trip Active or Latched	Class 1
78	RTD 11 Trip Active or Latched	Class 1
79	RTD 12 Trip Active or Latched	Class 1
80	Analog Input 1 Trip Active or Latched	Class 1
81	Analog Input 2 Trip Active or Latched	Class 1

Table 5: Binary Inputs (Sheet 3 of 4)

Idx	Description	Class
82	Analog Input 3 Trip Active or Latched	Class 1
83	Analog Input 4 Trip Active or Latched	Class 1
84	Loss of Excitation Circle 1 Trip Active or Latched	Class 1
85	Loss of Excitation Circle 2 Trip Active or Latched	Class 1
86	Ground Directional Trip Active or Latched	Class 1
87	High Set Phase Overcurrent Trip Active or Latched	Class 1
88	Distance Zone 1 Trip Active or Latched	Class 1
89	Distance Zone 2 Trip Active or Latched	Class 1
100	Assignable Input 1 Alarm Active / Latched	Class 1
101	Assignable Input 2 Alarm Active or Latched	Class 1
102	Assignable Input 3 Alarm Active or Latched	Class 1
103	Assignable Input 4 Alarm Active or Latched	Class 1
104	Assignable Input 5 Alarm Active or Latched	Class 1
105	Assignable Input 6 Alarm Active or Latched	Class 1
106	Assignable Input 7 Alarm Active / Latched	Class 1
107	Tachometer Alarm Active or Latched	Class 1
108	Overcurrent Alarm Active or Latched	Class 1
109	Negative Sequence Alarm Active or Latched	Class 1
110	Ground Overcurrent Alarm Active or Latched	Class 1
111	Undervoltage Alarm Active or Latched	Class 1
112	Overvoltage Alarm Active or Latched	Class 1
113	Volts/Hertz Alarm Active or Latched	Class 1
114	Underfreq Alarm Active or Latched	Class 1
115	Overfrequency Alarm Active or Latched	Class 1
116	Neutral Overvoltage Alarm Active or Latched	Class 1
117	Neutral Undervoltage (Third Harmonic) Alarm Active or Latched	Class 1
118	Reactive Power Alarm Active or Latched	Class 1
119	Reverse Power Alarm Active or Latched	Class 1
120	Low Forward Power Alarm Active / Latched	Class 1
121	RTD 1 Alarm Active or Latched	Class 1
122	RTD 2 Alarm Active or Latched	Class 1
123	RTD 3 Alarm Active or Latched	Class 1

Table 5: Binary Inputs (Sheet 4 of 4)

Idx	Description	Class
124	RTD 4 Alarm Active or Latched	Class 1
125	RTD 5 Alarm Active or Latched	Class 1
126	RTD 6 Alarm Active or Latched	Class 1
127	RTD 7 Alarm Active or Latched	Class 1
128	RTD 8 Alarm Active or Latched	Class 1
129	RTD 9 Alarm Active or Latched	Class 1
130	RTD 10 Alarm Active or Latched	Class 1
131	RTD 11 Alarm Active or Latched	Class 1
132	RTD 12 Alarm Active or Latched	Class 1
133	Open Sensor Alarm Active or Latched	Class 1
134	Short/Low Temp Alarm Active or Latched	Class 1
135	Thermal Model Alarm Active or Latched	Class 1
136	Trip Counter Alarm Active or Latched	Class 1
137	Breaker Failure Alarm Active or Latched	Class 1
138	Trip Coil Monitor Alarm Active or Latched	Class 1
139	VTFF Alarm Active or Latched	Class 1
140	Current Dmd Alarm Active or Latched	Class 1
141	MW Demand Alarm Active or Latched	Class 1
142	Mvar Demand Alarm Active or Latched	Class 1
143	MVA Alarm Active or Latched	Class 1
144	Analog Input 1 Alarm Active or Latched	Class 1
145	Analog Input 2 Alarm Active or Latched	Class 1
146	Analog Input 3 Alarm Active or Latched	Class 1
147	Analog Input 4 Alarm Active or Latched	Class 1
148	Not Programmed Alarm Active or Latched	Class 1
149	Simulation Mode Alarm Active or Latched	Class 1
150	Output Relays Forced Alarm Active or Latched	Class 1
151	Analog Output Forced Alarm Active or Latched	Class 1
152	Test Switch Shorted Alarm Active or Latched	Class 1
153	Ground Directional Alarm Active or Latched	Class 1
154	IRIG-B Failure Alarm Active or Latched	Class 1
155	Generator Running Hour Alarm Active or Latched	Class 1

NOTE

Any detected change in the state of any point assigned to Class 1 will cause the generation of an event object.

Binary / Control Relay Output Block (Objects 10/12)

Table 6: Binary Output Point List

INDEX	DESCRIPTION
0	Reset
1	Generator Start
2	Generator Stop
3	Clear Trip Counters
4	Clear Last Trip Data
5	Clear MWh and Mvarh
6	Clear Peak Demand Data
7	Clear Generator Information
8	Clear Breaker Information

The following restrictions should be noted when using object 12 to control the points listed above:

1. The **Count** field is checked first. If it is zero, the command will be accepted but no action will be taken. If this field is non-zero, the command will be executed exactly once regardless of its value.
2. The **Control Code** field of object 12 is then inspected:
   - The Queue and Clear sub-fields are ignored.
   - If the **Control Code** field is zero (i.e., NUL operation) the command is accepted but no action is taken.
   - For all points, the only valid control is "Close - Pulse On" (41 hex). This is used to initiate the function (e.g., Reset) associated with the point.
   - Any value in the **Control Code** field not specified above is invalid and will be rejected.
   - The **On Time** and **Off Time** fields are ignored. A "Pulse On" control takes effect immediately when received. Thus, the timing is irrelevant.
   - The **Status** field in the response will reflect the success or failure of the control attempt thus:
   - A Status of "Request Accepted" (0) will be returned if the command was accepted.
   - A Status of "Request not Accepted due to Formatting Errors" (3) will be returned if the **Control Code** field was incorrectly formatted or an invalid Code was present in the command.
   - A Status of "Control Operation not Supported for this Point" (4) will be returned if an attempt was made to operate the point and the relay, owing to its configuration, does not allow the point to perform its function.

An operate of the Reset point may fail (even if the command is accepted) due to other inputs or conditions (e.g., blocks) existing at the time. To verify the success or failure of an operate of this point it is necessary that the associated Binary Input(s) be examined after the control attempt is performed.

When using object 10 to read the status of any Binary Output, a value of zero will always be returned. This is due to the fact that all points are "Pulse On" and are deemed to be normally off.

Binary / Frozen Counter (Objects 20/21)

Table 7: Counters Point List

INDEX	ROLLOVER POINT	DESCRIPTION
0	50000	Number of Breaker Operations
1	50000	Number of Thermal Resets
2	50000	Number of Trips (total)
3	50000	Number of Digital Input Trips
4	50000	Number of Sequential Trips
5	50000	Number of Field-Breaker Discrepancy Trips
6	50000	Number of Tachometer Trips
7	50000	Number of Offline Overcurrent Trips
8	50000	Number of Phase Overcurrent Trips
9	50000	Number of Negative Sequence Overcurrent Trips
10	50000	Number of Ground Overcurrent Trips
11	50000	Number of Phase Differential Trips
12	50000	Number of Undervoltage Trips
13	50000	Number of Overvoltage Trips
14	50000	Number of Volts/Hertz Trips
15	50000	Number of Phase Reversal Trips
16	50000	Number of Underfrequency Trips
17	50000	Number of Overfrequency Trips
18	50000	Number of Neutral Overvoltage (Fundamental) Trips
19	50000	Number of Neutral Undervoltage (Third Harmonic) Trips
20	50000	Number of Reactive Power Trips
21	50000	Number of Reverse Power Trips
22	50000	Number of Underpower Trips
23	50000	Number of Stator RTD Trips
24	50000	Number of Bearing RTD Trips
25	50000	Number of Other RTD Trips
26	50000	Number of Ambient RTD Trips
27	50000	Number of Thermal Model Trips
28	50000	Number of Inadvertent Energization Trips
29	50000	Number of Analog Input 1 Trips
30	50000	Number of Analog Input 2 Trips
31	50000	Number of Analog Input 3 Trips
32	50000	Number of Analog Input 4 Trips
33	50000	Number of Loss of Excitation Circle 1 Trips
34	50000	Number of Loss of Excitation Circle 2 Trips
35	50000	Number of Ground Directional Trips
36	50000	Number of High Set Phase Overcurrent Trips
37	50000	Number of Distance Zone 1 Trips
38	50000	Number of Distance Zone 2 Trips

NOTE

The counters cannot be cleared with the Freeze/Clear function codes (9/10). Instead, the control relay output block points can be used to clear groups of counters. There is only one copy of each counter, so clearing a counter via Modbus or the front panel display causes the corresponding DNP counter point to be cleared and vice-versa.

Analog Input / Input Change (Objects 30/32)

In the following table, the Format column indicates that the associated data point format is determined by the entry in *Data Formats* on page 40. For example, an "F1" format is described in that table as a (16-bit) unsigned value without any decimal places. Therefore, the value read should be interpreted in this manner. Many of the values reported by the 489 have a size of 32-bits and have had their upper and lower 16-bit components assigned to separate points. Where indicated, refer to the appropriate note following the table for more detail.

Table 8: Analog Inputs Point List (Sheet 1 of 4)

INDEX	FOR-MAT	DESCRIPTION	EVENT CLASS ASSIGNED TO	NOTES
0	F133	Generator Status	Class 1	Note 3
1	F1	Generator Thermal Capacity Used	Class 1	
2	F1	Estimated Trip Time On Overload (seconds, 65535 means never)	Class 1	
3	F134	Cause Of Last Trip	Class 1	Note 3
4	F19	Time Of Last Trip (Upper 16 Bits)	Class 1	Notes 3,4
5	F19	Time Of Last Trip (Lower 16 Bits)	Class 1	Notes 3,4
6	F18	Date Of Last Trip (Upper 16 Bits)	Class 1	Notes 3,4
7	F18	Date Of Last Trip (Lower 16 Bits)	Class 1	Notes 3,4
8	F1	Tachometer Pre-Trip	Class 1	Note 3
9	F1	Scale factor for pre-trip current readings (pre-trip points marked with "Note 6"). Will always be a power of 10 (1, 10, 100, etc.). Changes only when the configuration setpoints are changed.	Class 1	Note 3
10	F1	Phase A Pre-Trip Current	Class 1	Notes 3, 6
11	F1	Phase B Pre-Trip Current	Class 1	Notes 3, 6
12	F1	Phase C Pre-Trip Current	Class 1	Notes 3, 6
13	F1	Phase A Pre-Trip Differential Current	Class 1	Notes 3, 6
14	F1	Phase B Pre-Trip Differential Current	Class 1	Notes 3, 6
15	F1	Phase C Pre-Trip Differential Current	Class 1	Notes 3, 6
16	F1	Pre-Trip Negative Sequence Current	Class 1	Note 3
17	F1	Ground Current Scale Factor. Will always be a power of 10 (1, 10, 100, etc.). Changes only when the configuration setpoints are changed.	Class 1	Note 3
18	F6	Pre-Trip Ground Current (scaled according to previous setpoint)	Class 1	Note 3
19	F1	Phase A-B Pre-Trip Voltage	Class 1	Note 3
20	F1	Phase B-C Pre-Trip Voltage	Class 1	Note 3
21	F1	Phase C-A Pre-Trip Voltage	Class 1	Note 3
22	F3	Pre-Trip Frequency	Class 1	Note 3
23	F1	Pre-Trip Real Power (MW)	Class 1	Notes 3,8
24	F1	Pre-Trip Real Power (kW)	Class 1	Notes 3,8
25	F1	Pre-Trip Reactive Power (Mar	Class 1	Notes 3,8
26	F1	Pre-Trip Reactive Power (kvar)	Class 1	Notes 3,8
27	F1	Pre-Trip Apparent Power (MVA)	Class 1	Notes 3,8
28	F1	Pre-Trip Apparent Power (kVA)	Class 1	Notes 3,8
29	F1	Last Trip Stator RTD	Class 1	Note 3
30	F4	Last Trip Hottest Stator RTD Temperature (°C)	Class 1	Note 3
31	F1	Last Trip Bearing RTD	Class 1	Note 3
32	F4	Last Trip Hottest Bearing RTD Temperature (°C)	Class 1	Note 3
33	F1	Last Trip Other RTD	Class 1	Note 3
34	F4	Last Trip Hottest Other RTD Temperature (°C)	Class 1	Note 3

Table 8: Analog Inputs Point List (Sheet 2 of 4)

INDEX	FOR-MAT	DESCRIPTION	EVENT CLASS ASSIGNED TO	NOTES
35	F1	Last Trip Ambient RTD	Class 1	Note 3
36	F4	Last Trip Hottest Ambient RTD Temperature (°C)	Class 1	Note 3
37	F12	Pre-Trip Analog Input 1	Class 1	Notes 3,9
38	F12	Pre-Trip Analog Input 2	Class 1	Notes 3,9
39	F12	Pre-Trip Analog Input 3	Class 1	Notes 3,9
40	F12	Pre-Trip Analog Input 4	Class 1	Notes 3,9
41	F1	Pre-Trip Fundamental Frequency Neutral Voltage (volts)	Class 1	Notes 3,10
42	F10	Pre-Trip Fundamental Frequency Neutral Voltage (tenths of a volt)	Class 1	Notes 3,10
43	F1	Pre-Trip Third Harmonic Neutral Voltage (volts)	Class 1	Notes 3,10
44	F10	Pre-Trip Third Harmonic Neutral Voltage (tenths of a volt)	Class 1	Notes 3,10
45	F2	Pre-Trip Vab/Iab (loss of excitation impedance)	Class 1	Note 3
46	F1	Pre-Trip Vab/Iab Angle (loss of excitation impedance angle)	Class 1	Note 3
47	F1	Scale factor for current readings (points marked with "Note 7"). Will always be a power of 10 (1, 10, 100, etc.). Changes only when the configuration setpoints are changed.	Class 1	Note 3
48	F1	Phase A Output Current	Class 2	Note 7
49	F1	Phase B Output Current	Class 2	Note 7
50	F1	Phase C Output Current	Class 2	Note 7
51	F1	Phase A Neutral-Side Current	Class 2	Note 7
52	F1	Phase B Neutral-Side Current	Class 2	Note 7
53	F1	Phase C Neutral-Side Current	Class 2	Note 7
54	F1	Phase A Differential Current	Class 2	Note 7
55	F1	Phase B Differential Current	Class 2	Note 7
56	F1	Phase C Differential Current	Class 2	Note 7
57	F1	Average Phase Current	Class 2	Note 7
58	F1	Generator Load (percent)	Class 2	
59	F1	Negative Sequence Current	Class 2	
60	F1	Ground Current Scale Factor. Will always be a power of 10 (1, 10, 100, etc.). Changes only when the configuration setpoints are changed.	Class 1	Note 3
61	F3	Ground Current (scaled according to the previous point)	Class 2	
62	F1	Phase A-B Voltage	Class 2	
63	F1	Phase B-C Voltage	Class 2	
64	F1	Phase C-A Voltage	Class 2	
65	F1	Average Line Voltage	Class 2	
66	F1	Phase A-N Voltage	Class 2	
67	F1	Phase B-N Voltage	Class 2	
68	F1	Phase C-N Voltage	Class 2	
69	F1	Average Phase Voltage	Class 2	
70	F3	Per Unit Measurement Of V/Hz	Class 2	
71	F3	Frequency	Class 2	Note 2
72	F1	Fundamental Frequency Neutral Voltage (volts)	Class 2	Note 10
73	F10	Fundamental Frequency Neutral Voltage (tenths of a volt)	Class 2	Note 10

Table 8: Analog Inputs Point List (Sheet 3 of 4)

INDEX	FOR-MAT	DESCRIPTION	EVENT CLASS ASSIGNED TO	NOTES
74	F1	Third Harmonic Neutral Voltage (volts)	Class 2	Note 10
75	F10	Third Harmonic Neutral Voltage (tenths of a volt)	Class 2	Note 10
76	F1	Third Harmonic Terminal Voltage (volts)	Class 2	Note 10
77	F10	Third Harmonic Terminal Voltage (tenths of a volt)	Class 2	Note 10
78	F2	Vab/Iab (loss of excitation impedance)	Class 2	
79	F1	Vab/Iab Angle (loss of excitation impedance angle)	Class 2	
80	F6	Power Factor	Class 2	
81	F1	Real Power (MW)	Class 2	Note 8
82	F1	Real Power (kW)	Class 2	Note 8
83	F1	Reactive Power (Mar)	Class 2	Note 8
84	F1	Reactive Power (kvar)	Class 2	Note 8
85	F1	Apparent Power (MVA)	Class 2	Note 8
86	F1	Apparent Power (kVA)	Class 2	Note 8
87	F1	Hottest Stator RTD	Class 2	Note 3
88	F4	Hottest Stator RTD Temperature (°C)	Class 2	
89	F4	RTD #1 Temperature (°C)	Class 2	
90	F4	RTD #2 Temperature (°C)	Class 2	
91	F4	RTD #3 Temperature (°C)	Class 2	
92	F4	RTD #4 Temperature (°C)	Class 2	
93	F4	RTD #5 Temperature (°C)	Class 2	
94	F4	RTD #6 Temperature (°C)	Class 2	
95	F4	RTD #7 Temperature (°C)	Class 2	
96	F4	RTD #8 Temperature (°C)	Class 2	
97	F4	RTD #9 Temperature (°C)	Class 2	
98	F4	RTD #10 Temperature (°C)	Class 2	
99	F4	RTD #11 Temperature (°C)	Class 2	
100	F4	RTD #12 Temperature (°C)	Class 2	
101	F1	Current Demand	Class 2	Note 7
102	F1	MW Demand	Class 2	Note 8
103	F1	kW Demand	Class 2	Note 8
104	F1	Mvar Demand	Class 2	Note 8
105	F1	kvar Demand	Class 2	Note 8
106	F1	MVA Demand	Class 2	Note 8
107	F1	kVA Demand	Class 2	Note 8
108	F1	Peak Current Demand	Class 2	Note 7
109	F1	Peak MW Demand	Class 2	Note 8
110	F1	Peak kW Demand	Class 2	Note 8
111	F1	Peak Mvar Demand	Class 2	Note 8
112	F1	Peak kvar Demand	Class 2	Note 8
113	F1	Peak MVA Demand	Class 2	Note 8
114	F1	Peak kVA Demand	Class 2	Note 8
115	F12	Analog Input 1	Class 2	Note 9
116	F12	Analog Input 2	Class 2	Note 9
117	F12	Analog Input 3	Class 2	Note 9
118	F12	Analog Input 4	Class 2	Note 9
119	F1	Tachometer RPM	Class 2	
120	F1	Average Generator Load	Class 2	

Table 8: Analog Inputs Point List (Sheet 4 of 4)

INDEX	FOR-MAT	DESCRIPTION	EVENT CLASS ASSIGNED TO	NOTES
121	F1	Average Negative Sequence Current	Class 2	
122	F1	Average Phase-Phase Voltage	Class 2	
123	-	User Map Value 1		Note 5
124	-	User Map Value 2		Note 5
↓	↓	...↓...	↓	↓
246	-	User Map Value 124		Note 5
247	-	User Map Value 125		Note 5
248	F118	Active Setpoint Group	Class 1	Note 3
249	F13	Positive kWh	Class 2	
250	F13	Positive kvarh	Class 2	
251	F13	Negative kvarh	Class 2	
252	F12	Generator Hours Online	Class 2	

TABLE NOTES:

1. Unless otherwise specified, an event object will be generated for a point if the current value of the point changes by an amount greater than or equal to two percent of its previous value.
2. An event object is created for the Frequency point if the frequency changes by 0.04 Hz or more from its previous value.
3. An event object is created for these points if the current value of a point is in any way changed from its previous value.
4. To support existing SCADA hardware that is not capable of 32-bit data reads, the upper and lower 16-bit portions of these 32-bit values have been assigned to separate points. To read this data, it is necessary to read both the upper and lower 16-bit portions, concatenate these two values to form a 32-bit value and interpret the result in the format associated with the point as specified in *Data Formats* on page 40.
5. The data returned by a read of the User Map Value points is determined by the values programmed into the corresponding User Map Address registers (which are only accessible via Modbus). Refer to *User-Definable Memory Map Area* on page 9 for more information. Changes in User Map Value points never generate event objects. Note that it is possible to refer to a 32-bit quantity in a user map register, which may require the use of a 32-bit variation to read the associated analog input point.
6. The scale for pre-trip currents is determined by the value in point 9, which should not normally change
7. The scale for currents is determined by the value in point 47, which should not normally change
8. Each power quantity is available at two different points, with two different scale factors (kW and MW, for example). The user should select the unit which is closest to providing the resolution and range desired. If 32-bit analog input capability is present, the higher-resolution (kW, kvar, kVA) points should generally be used, since they provide the greatest resolution.
9. Analog input values may be –50000 to +50000 if so configured. Therefore, 32-bit analog input capability is required to read the full possible range. If the SCADA equipment can only read 16-bit registers, the analog inputs should be configured to operate within the range –32768 to +32767.
10. Each neutral voltage quantity is available at two different points, with two different scale factors (volts and tenths of a volt). The user should select the unit which is closest to providing the resolution and range desired. If 32-bit analog input capability is present, the higher-resolution (tenths of a volt) points should generally be used, since they provide the greatest resolution.

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